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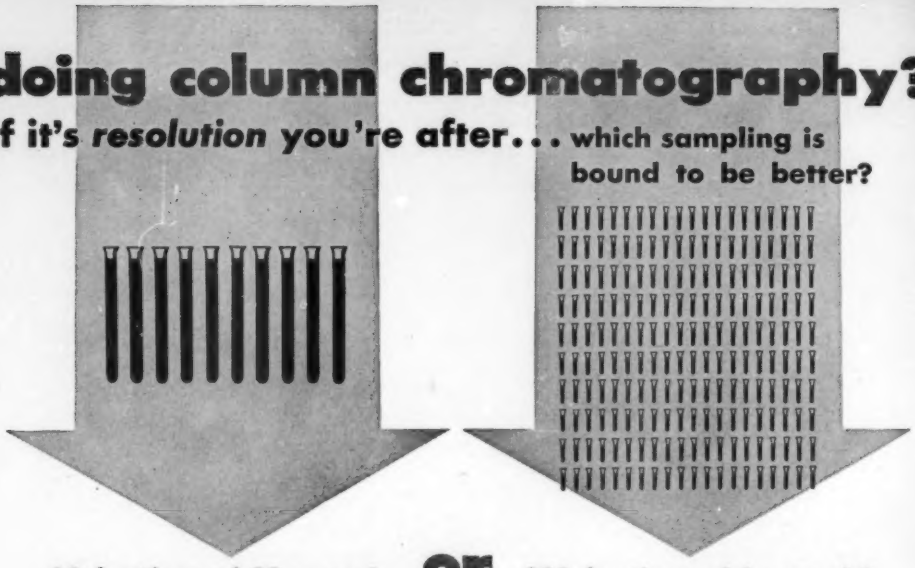

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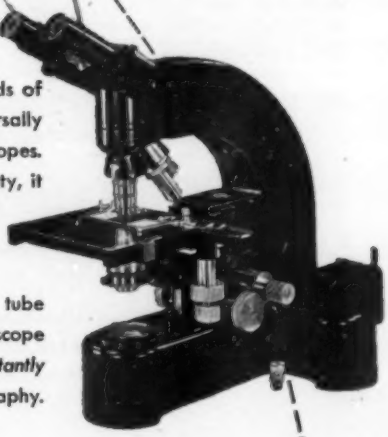

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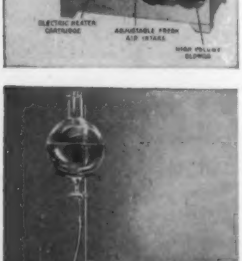

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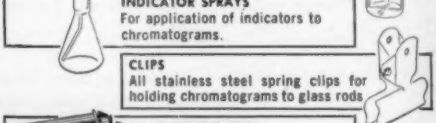

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American Institute of Biological Sciences

THE American Institute of Biological Sciences, a voluntary association of organizations which have in common an interest in the life sciences, was founded in 1948 under the sponsorship of the National Research Council. The present membership of the AIBS includes seventeen member societies, ten affiliate societies, and eighteen associates. The total membership of the twenty-seven societies exceeds 30,000.

The current program of the AIBS includes many activities of interest and value to biologists. The AIBS BULLETIN serves as a forum for the discussion of subjects of general interest to biologists. A series of provocative articles on the training of biologists is now being published. Another series, on the agencies which support research in biology, is continuing. As a contribution to vocational guidance, leaders in the field of biology have been invited to prepare inspirational "guest editorials," the first of which will appear in the July issue of the BULLETIN. The AIBS Placement Service is a liaison between biologists and prospective employers. Plans are well underway for the AIBS-sponsored meeting of biological societies to be held at the University of Wisconsin on September 6–10, 1953. The "Bio-Sciences Newsletter," prepared in the AIBS office and distributed by the State Department throughout the world, carries news of biological progress in the United States. Advisory Committees on Biology, Biochemistry, and Physiology assist the Office of Naval Research in evaluating the scientific merit of research proposals in those fields. An Advisory Committee on Hydrobiology, also under an ONR contract, is preparing a directory of hydrobiology stations and personnel. The AIBS and the Federation of American Societies for Experimental Biology have been called upon to name individuals to represent the field of biology on the Scientific Manpower Commission. The first fascicle of the *Handbook of Biological Data*, entitled "Standard Values in Blood," has appeared in book form, published by the W. B. Saunders Company. Other fascicles in the series, which will include "Nutrition and Metabolism," "Growth and Reproduction," "Performances," "Biochemical Composition," and a fascicle containing miscellaneous tables, are in preparation. As an outgrowth of a series of conferences sponsored by the Division of Biology and Agriculture of the National Research Council, and in which the needs for adequate standards and methods in the procurement of biological materials for research, assaying, testing, and teaching were recognized, an Institute of Animal Resources has been established as a subunit in the Division and assigned to the administrative sphere of the AIBS. In setting up the National Science Foundation, Congress directed that a register of scientific and technical personnel be maintained as a part of a central clearinghouse for information on such personnel. According to present plans, the register will be organized, on a decentralized basis, through the cooperation of such groups as the Federation of American Societies for Experimental Biology and the AIBS, representing the field of biology.

Many other activities have been undertaken by AIBS as a service to biologists. Problems involved in the publication of scientific journals are constantly studied. Opportunities for biologists in commercial and industrial enterprises are being investigated. The AIBS transmits to biologists information relative to international congresses and other meetings held abroad; it is in a position to work with the Office of Scientific Personnel, the National Science Foundation, Selective Service, and the military services on matters pertaining to biologists.

A few years ago, the American Institute of Biological Sciences was an idea in the minds of a few biologists. Today it is an established fact.

SAMUEL L. MEYER

Executive Director, AIBS

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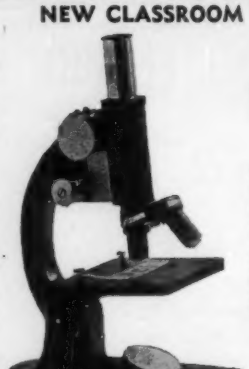

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Funds for Science: The Federal Government and Nonprofit Institutions

Charles G. Gant and Bertha Rubinstein
National Science Foundation

IT IS HARDLY NEWS that the Federal Government has become the major source of funds for scientific research and development in the United States. This is not *news*; but it is *new*. In 1940 the Federal Government spent slightly less than 100 million dollars for all types of scientific activities; in 1952, just over a decade later, it spent almost 1.9 billion dollars. In the latter year the total national expenditure for research and development probably amounted to 3.3 billion dollars. Three-fifths of the Nation's research and development bill is thus being paid out of the Federal Treasury.

It is not new, of course, for the Federal Government to engage in scientific activities. Federal agencies have for many years conducted research and development in a variety of fields. What is new, aside from the growth in magnitude of the expenditures themselves, is the extent to which the Government now "sponsors" research and development at non-governmental organizations, rather than conducting such work in its own laboratories. In 1940 sponsored research and development probably accounted for less than 10 per cent of all governmental expenditures for this purpose; in 1952, it accounted for 75 per cent.

Industrial and commercial organizations are performing the major portion of this research and development which the Government pays for, but does not itself do. In 1952 such organizations received about 60 per cent of all federal research and development funds. But nonprofit institutions, i.e., hospitals, independent research institutes, professional societies, and, above all, institutions of higher learning are also participating extensively in government-sponsored research and development. Although the portion of the total federal research and development budget, about 15 per cent, going to nonprofit institutions is less than that required for research and development done in government laboratories or by industrial organizations for the Government, it is nevertheless a significant amount both in absolute terms and in relation to other sources of funds available to these institutions for research and development.

A growing interest, not to say concern, has become evident in many quarters as to what the effects and implications of this increased government sponsorship of research and development at nonprofit institutions might be. To fill the need for factual information on the subject, the National Science Foundation has recently completed a study of the funds administered by federal agencies for research and development at nonprofit institutions during the two years 1950–51 and 1951–52.[1] This paper summarizes the more important findings of the study; for full details the reader is referred to the complete report being issued by the Foundation.

Total funds and administering agencies. According to the study, federal agencies administered 338 million dollars for scientific research and development at nonprofit institutions in 1951–52. This is an increase of 15 per cent over the 294 million dollars administered for this purpose in 1950–51.

Although the funds at nonprofit institutions increased between the two years, the relative share of nonprofit institutions in the research and development expenditures of the Federal Government decreased slightly. Such institutions received 16 per cent of all federal research and development funds in 1950–51, but only 15 per cent in the later year. The increase in funds at nonprofit institutions between the two years, while fairly significant in itself, does not greatly alter the distribution among administering agencies, receiving institutions, or the nature of the work sponsored. Subsequent analyses of the total funds are confined therefore to the 338 million dollars reported for 1951–52.

In 1951–52, 17 agencies of the Government sponsored research and development at nonprofit institutions. In reporting funds for this purpose these agencies were guided by the following definition supplied by the Foundation: scientific research and development is systematic, intensive study directed toward fuller knowledge of the subject studied and the systematic use of that knowledge for the production of useful materials, systems, methods, or processes. The term was further to be construed broadly to include all costs related to or associated with the conduct of research and development except the dissemination of scientific information and the training of scientific manpower. For the most part, funds for this purpose were reported on the basis of "obligations incurred" by the agency, rather than payments made to the institution, during the year involved. As a result, the

[1] *Federal Funds for Science: I—Federal Sponsorship of Research and Development at Nonprofit Institutions, 1950–1951 and 1951–1952* (Washington, 1953). The report is available from the Superintendent of Documents.

figures overstate in total the amount of payments made to all institutions by 15 to 25 per cent in 1951–52; for individual institutions, the variation may be considerably greater.

Although a sizable number of agencies reported funds in 1951–52, the bulk was administered by four large agencies (see Fig. 1), which administered 98 per cent of the funds. The Department of Defense accounted for 53 per cent of the total, the Atomic Energy Commission for 36 per cent, the Federal Security Agency[2] for 5 per cent, and the Department of Agriculture for 4 per cent. The other 13 agencies obligated only 2 per cent of the total—7.5 million dollars.

Each of the three subdivisions of the Department of Defense administered a greater sum than any of the other agencies except the Atomic Energy Commission. The Department of the Navy accounted for 64 million dollars, 36 per cent of Defense's total. Within the Navy, the Office of Naval Research and the Bureau of Ordnance reported the bulk of the obligations, 37 million and 19 million dollars respectively. The Department of the Air Force accounted for 62 million dollars, that entire amount being administered by the Air Research and Development Command. The Department of the Army administered 51 million dollars, with the Army Ordnance Corps responsible for 30 million dollars.

Single subdivisions of the Federal Security Agency and the Department of Agriculture reported the greater part of the funds administered by those agencies. Funds for the Federal Security Agency represent the grants program of the National Institutes of Health of the Public Health Service. Over 90 per cent of Agriculture's funds were grants-in-aid allocated to the agricultural experiment stations and administered by the Office of Experiment Stations.

As previously pointed out, the sponsoring of research and development at nonprofit institutions is only one of three methods by which the Federal Government carries out its research and development activities, and, in magnitude of funds involved, it is the least significant. The federal agencies, of course, vary greatly in their utilization of the research resources of nonprofit institutions. For example, funds of the Department of Defense loom large in this study, representing over 50 per cent of the funds going to nonprofit institutions; yet these funds were only about 10 per cent of that agency's total obligations in 1951–52 for research and development. By contrast, the other three agencies administering sizable portions of the total funds—the Atomic Energy Commission, Department of Agriculture, and Federal Security Agency—obligated from one-quarter to one-half of their total funds at nonprofit institutions.

The recipient institutions. The total of 338 million dollars in 1951–52 was distributed to 427 institutions. Of these, 403 were located in the United States,

[2] Under Reorganization Plan No. 1, 83rd Congress, approved April 1, 1953, the Federal Security Agency was absorbed in the newly created Department of Health, Education, and Welfare.

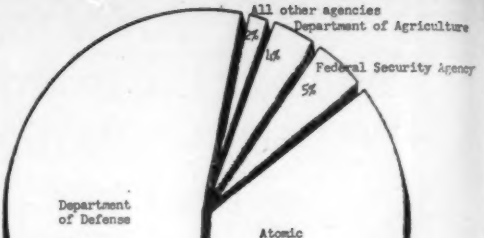

FIG. 1. Four agencies distributed 98 per cent of the funds, 1951–52.

Alaska, Hawaii, and Puerto Rico. The remainder (24) were in foreign countries and accounted for a relatively small portion of the total funds, 0.8 million dollars. These foreign institutions have been eliminated in the analyses which follow.

A large variety of institutions was represented. Most numerous were educational institutions, and foremost in this group was the large university. But the Government also sponsors research and development in many small colleges, in a number of hospitals and related medical institutions, in independent research organizations, and in a group of associations, boards, museums, and the like, whose excursions into research are not always readily apparent from their primary purpose.

In the distribution of total funds by institutional types, the *educational institutions* dominate (see Fig. 2). Two hundred and twenty-five educational institutions received 295 million dollars in 1951–52. Representing 56 per cent of the total number of institutions, they received approximately 87 per cent of the total funds. Because of their relative importance, more detailed information on funds going to educational institutions is given in a subsequent section.

The three institutions classified as *special research organizations* are closely related to educational institutions. Two of the three are the Brookhaven National Laboratory and the Oak Ridge Institute of Nuclear Studies, both sponsored by the Atomic Energy Commission and operated under the joint auspices of groups of universities. The third is the Rand Corporation, which derives its support from the Air Force and is operated by an independent organization. In all cases, however, the special research organizations are creations of the Federal Government, legally and administratively separate from any operating organization, and hence they constitute a separate institutional class.

Eighty *hospitals* were reported as receiving a total of 4.6 million dollars in 1951–52, 1 per cent of all funds. Significantly, all these hospitals had some training function. However, compared with the total number of hospitals affiliated with a medical school or approved for the training of interns (over 2000), the number conducting research is small. It would seem, in relation to the total scientific research picture, that hospitals per se do not constitute a very significant research resource for the Federal Government.

The most significant characteristic of the *independent research organizations* is that, with the exception of the special research centers formed at the request of the Government, they are the sole institutional group whose primary purpose is the conduct of scientific research and development. Although the earliest such research institute was established around 1913, their number and importance have increased in recent years. Of the 48 independent research organizations which received funds from the Federal Government in 1951–52, almost half have been established within the last 20 years and many of them during and since World War II. These organizations, such as the Battelle Memorial Institute, the Armour Research Foundation, and the Stanford Research Institute, received a total of 17 million dollars in 1951–52. During the two years for which data are available, the number of such organizations participating in federally sponsored research and development increased from 43 to 48. It may be hypothesized that with a continued availability of funds for the sponsorship of scientific research and development, the importance, as well as the number, of these organizations will tend to increase as a significant research resource for the Federal Government.

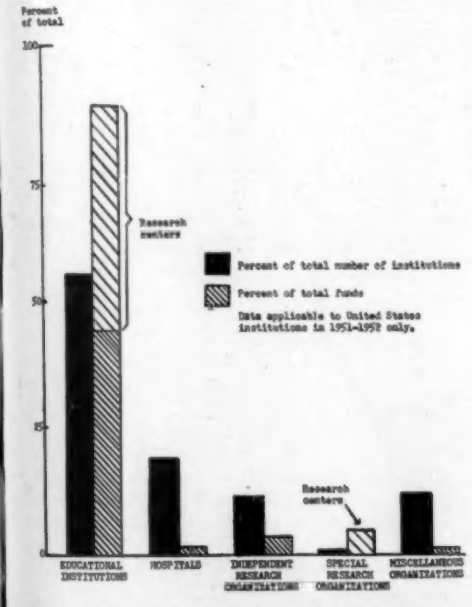

FIG. 2. The educational institutions led in numbers, even more so in funds.

Forty-seven *miscellaneous organizations* received a total of 5 million dollars in 1951–52. About a third (17) of these were private societies and trade associations; a second group (11) was composed of units of state and local governments; and the remainder were libraries, botanical gardens, museums, and the like.

In the above analysis, institutions have been classified according to their primary purpose. However, the great increase in federally sponsored research and development at nonprofit institutions in the last decade has fostered what is almost a new institutional form, the "research centers." Some appreciation of the nature of these centers is essential to a proper understanding of the funds going to nonprofit institutions in general.

Research centers, as the term is used here, are large research and development projects administered by nonprofit institutions for the Federal Government. For the most part these centers have been established at the request of the Government and represent a continuing collaboration between the Government and the institution, in which the Government determines the general work plan of the center while the contracting institution provides principally managerial services. With respect to its substantive work, the center tends to be a self-contained entity, and its operations are usually characterized by some degree of segregation from other research and development done by the institution. In all cases, there is an administrative segregation, and, in many cases, a physical segregation as well. Originally pioneered during World War II to assist the Government in carrying out certain emergency projects, the research center, operated under contract, has now become an accepted administrative device through which the Government fulfills certain of its research and development needs.

In 1951–52, 24 research centers received funds. All but three were operated by educational institutions. Some of the larger and better known are the Los Alamos Scientific Laboratory (operated by the University of California for the Atomic Energy Commission), the Johns Hopkins Applied Physics Laboratory (operated by Johns Hopkins University for the Department of Defense), the Argonne National Laboratory (operated by the University of Chicago for the Atomic Energy Commission), and the Government Laboratories (operated by the University of Akron for the Reconstruction Finance Corporation). The three not operated by an educational institution are the three special research organizations already discussed above.

The costs of these centers absorbed nearly half (47 per cent) of the funds going to nonprofit institutions. In 1951–52 the amount involved was 159 million dollars. The work of the centers is largely defense-

FIG. 3. Geography of the funds.

oriented and defense-related. With one exception, funds for all 24 centers in 1951–52 were supplied by two agencies, both of which are concerned with large-scale defense-type operations—the Atomic Energy Commission and the Department of Defense.

Geographical distribution. There was at least one nonprofit institution receiving funds in each of the 48 states, the District of Columbia, Alaska, Hawaii, and Puerto Rico.[3] There were, however, significant differences in the geographical distribution of both the institutions and the funds. One state, New York, was the principal location of 71, or 18 per cent of the institutions. Twenty-four of the 52 jurisdictions had 3 or fewer institutions. Four states received 25 million dollars or more; thirteen received less than half a million dollars.

On a regional basis (Fig. 3), the Middle Atlantic, Central, Far West, and New England states accounted for 92 per cent of the total funds. The remaining 3 regions and the outlying parts received 8 per cent. The Middle Atlantic States had a far larger number of institutions receiving funds than any of the other regions and led slightly in terms of the percentage of funds received when research centers are excluded. The Far West led in percentage of total funds, largely because of the inclusion of the Los Alamos Scientific Laboratory with California. Table 1 illustrates well the effect of research center funds in changing the ranking of the regions. The four regions lead although the rank order changes.

TABLE 1

PERCENTAGE DISTRIBUTION OF INSTITUTIONS AND FUNDS BY REGION
1951–52

Region	Number institutions	Total funds	Without research centers
New England	12.4	13.3	19.6
Middle Atlantic	34.2	24.2	26.9
Southeast	11.9	4.0	7.3
Southwest	5.2	2.1	3.9
Central	18.4	23.9	26.7
Northwest	6.7	1.7	3.2
Far West	10.2	30.5	11.9
Territories	1.0	0.3	0.5
Total	100.0	100.0	100.0

Source: National Science Foundation.

On an individual state basis there are four key states, Massachusetts, New York, Illinois, and California. These four form the core of the four leading regions. Significantly all are the seats of research center activity.

The funds for research centers tend to increase the concentration of funds. Of the total funds, 7 states received 80 per cent; however, without research centers, these same 7 received only 64 per cent. The geographical distribution is not a uniform one, but the distribution of research resources and research potential is also not uniform. Because of their magnitude, the distribution of federal funds may well be interpreted as a reflection of the location of the scientific research resources of the nation.

Analysis of the work sponsored. It is important to distinguish between two different motivations which may prompt the Federal Government to sponsor research and development. In one instance, the Government's purpose may be simply to increase the existing body of scientific knowledge. In this case, the Government is *supporting* scientific activity. However, if it is seeking specific information to assist in carrying out a program (other than the support of research and development) for which it is responsible, the Government is then *purchasing* scientific services. Although in the latter case the specialized nature of the object, the production of new knowledge, may soften or blur the character of the negotiation, the relationship between the Government and the contracting institution is essentially that of buyer and seller.

Some programs of the federal agencies fall clearly in one or the other category. But, as in any dichotomy of this type, there are programs in which the distinction is not always obvious. Scientific knowledge sought by an agency for the sole purpose of solving some problem may have general applications far beyond the specific need prompting the work in the first instance. Conversely, information developed in a general support program may prove useful in meeting specific needs. The interests of many agencies, the Department of Defense in particular, are so broad that much scientific knowledge, even the most abstract, may be interpreted as having a possible relation to their missions.

Programs which may be clearly labeled "support" are, in order of magnitude, the contract research program of the Office of Naval Research, the grants program of the National Institutes of Health, payments to agricultural experiment stations by the Department of Agriculture, and the research support program of the National Science Foundation. In addition, there are a number of programs which bear many of the characteristics of both types of research sponsorship. These mixed programs, primarily in the Department of Defense and the Atomic Energy Commission, are undertaken to assist in carrying out an agency mission, but they are often extremely broad in coverage and may bear only an indirect relation to current agency needs.

Funds for the programs devoted primarily to support of scientific research and development amounted to 58 million dollars in 1951–52. In addition, funds for support included in the mixed programs were approximately 15 million dollars. Thus, it would appear that total funds for support of research and development were of the order of 75 million dollars, or slightly more than 20 per cent of the total, with the remainder going for the purchase of research and development.

[3] Those institutions located in foreign countries have been omitted in this analysis, as they were in the preceding discussion of recipient classes.

This 1:4 ratio has important consequences on every facet of the problem studied here. In purchasing services from an institution, the contracting agency is necessarily limited by the nature of its need. Its needs may be concentrated in a particular scientific area or require a specialized talent, thus forcing it to locate an institution which can perform the required services quickly and economically. Principal emphasis must be on the existing research capacity of an institution, whereas agencies supporting research may also take into consideration the potential of an institution, geographical factors, and similar factors. The bulk of the funds, however, were used for the *purchase* of research and development services and the findings of this study must be so interpreted.

As might be expected, a wide variety of scientific projects, covering many disciplines, comprise the total of 338 million dollars obligated for research and development in 1951–52. In an effort to classify the types of research involved, two sets of categories were used.

First, the agencies were asked to report the data according to the character of the work, i.e., whether it was for "basic research," "applied research," "development," or for "increase of research and development plant." The classificatory decisions were made by the agencies participating in the study, using definitions submitted by the Foundation.[4]

In 1951–52, applied research received 50.1 per cent of the funds (170 million dollars), developmental activity 22.9 per cent (77 million dollars), and basic research 21.0 per cent (71 million dollars). Funds for the increase of research and development plant represented 6.0 per cent of the total, or 20 million dollars. This last figure includes only funds specifically reported for this purpose, and therefore represents large, general-purpose construction.

The second classification used was that of the scientific field covered. Agencies were requested to assign the funds for individual projects to the most appropriate of the following headings: (1) the life sciences —biological, medical, and agricultural sciences; (2) the physical sciences—physical sciences proper, mathematical, and engineering sciences; and (3) the social sciences. Again, many problems are inherent in such an attempt to pigeonhole scientific research and development. Many of the undertakings reported here are large, interdisciplinary projects, which as a practical matter were classified in the category corresponding to their primary emphasis. There is, too, a tendency for the basic mission of a reporting agency to influence the classification of its funds.

Within the limitations of the data, it may be seen that the bulk of the funds were assigned for work in the physical sciences. In 1951–52, life sciences received 19 per cent of the total funds, social sciences 3 per cent, increase of research and development plant 6 per cent. The largest portion, 72 per cent, was reported for the physical sciences. The research centers, absorbing almost half of the total funds, are concentrated in this latter category, and when the funds for research center activity are excluded, the pattern shifts significantly. Physical sciences then received only 63 per cent of the total, life sciences 31 per cent, the social sciences 5 per cent, and increase of research and development plant 1 per cent.

The role of educational institutions. Colleges and universities traditionally have been considered as the seats of advanced learning and scholarly research in the United States. They have, indeed, long been considered as the natural, and almost sole, home of basic or pure research. For many years, the only direct research aid that educational institutions received from the Federal Government was that of the grants to agricultural experiment stations attached to land-grant schools.

As the Federal Government has felt the need to increase its sponsored work, it understandably turned to the colleges and universities. These institutions represented one of the largest available sources of scientific manpower and facilities. The extent to which the Government has come to rely on them is evident from the data presented in this study.

In receiving the bulk of the funds, the educational institutions set the pattern for this entire study. It then becomes important to inquire into the number of participating institutions and the distribution of funds among them.

Two hundred and twenty-five educational institutions received funds for research and development from the Federal Government in 1951–52. There are, according to the United States Office of Education, 1871 institutions of higher education in the United States and its outlying parts. If junior colleges, seminaries, teachers colleges, independent schools of art and music, and unaccredited institutions are subtracted, there remain approximately 687 schools in which one might expect present research activity or the capacity to develop such activity. Of these potential 687 institutions, only 225 were actually conducting research under the sponsorship of the Federal Government.

Thirty-nine per cent of the recipient educational institutions were "universities," i.e., complex educational centers composed of several schools and awarding the doctor's degree. Eighteen per cent were professional-technical schools. The remainder were liberal arts colleges.[5] The distribution of funds, however, was not at all similar to the distribution of types of program. Universities received 77 per cent of the funds going to educational institutions, professional-technical schools 20 per cent, and liberal arts colleges 3 per cent.

Individual institutions varied widely in the amounts of funds received. One institution was reported as receiving 70 million dollars in 1951–52; at the other

[4] The reader is referred to the complete report of this study for the definitions used for both character and field of work.

[5] The definitions of the various educational program types and examples are to be found in the complete report.

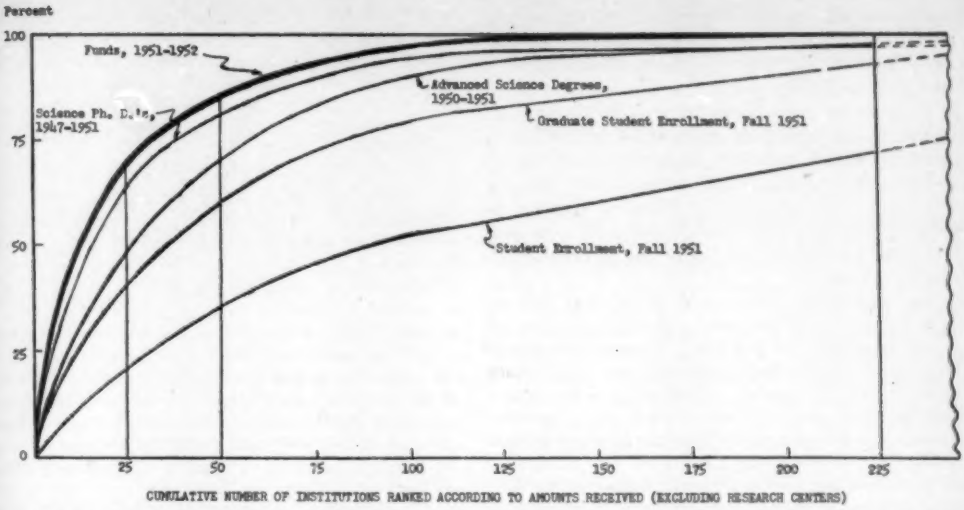

FIG. 4. Concentration of funds at educational institutions compared with concentration of selected measures of institutional size.

extreme, three institutions were reported receiving one thousand dollars or less. Five institutions received 55 per cent of the total funds going to educational institutions, and the top 50, approximately 91 per cent. Without the funds for research centers, the leading 5 institutions received 29 per cent, and the leading 50 received 83 per cent. Although the rank order of the leading educational institutions changes slightly when funds for research centers are excluded, there are no major changes in the list of the 50 educational institutions conducting the largest amounts of federally sponsored research.

It would, of course, be desirable to have objective criteria for the evaluation of the research capacity of an educational institution. Such a task is confronted with certain handicaps at the present time. Both the decision on the part of the Federal Government to contract with a given educational institution for scientific research and development and the institution's decision to accept—or even to seek—research contracts are governed by factors which cannot be measured quantitatively and which are not necessarily related to research capacity. There are, however, certain measures on which objective data are available which give some indication, however limited, of the research capacity of an educational institution. These are student enrollment, graduate student enrollment, advanced (master's, second professional, and above) degrees in science, and doctorates awarded in the sciences. When compared with these, federal research funds show a somewhat greater concentration than do any of the indices (see Fig. 4). For example, the 50 institutions receiving the largest amounts of funds received 83 per cent of all funds (excluding those for research centers), but enrolled only 35 per cent of the total student population. As the indices become more refined, the disparity between each of them and the funds becomes less. The 50 ranking institutions accounted for 60 per cent of the graduate student population, and awarded 67 per cent of the advanced science degrees and 83 per cent of the science doctorates.

Within the educational institutions conducting substantial amounts of research, several components can be identified (see Table 2). Their isolation and a proper view of their role are essential to a true understanding of the effect and influence of federal research funds in the academic setting.

Most prominent in terms of funds are the research centers which have been discussed previously. Although the centers must rightly be considered as a part of the over-all research effort at non-profit institutions, these funds do not flow into the mainstream of educational activity, but represent instead a segregated, specialized effort.

TABLE 2

FUNDS AT EDUCATIONAL INSTITUTIONS BY RESEARCH COMPONENTS
1951–52

Research component	Amount (thousands of dollars)	Percentage of total funds
Instructional departments	135,834	46.1
Affiliated research organizations	2,943	1.0
Agricultural experiment stations	12,460	4.2
Research centers	143,480	48.7
Total	294,717	100.0

Source: National Science Foundation.

Agricultural experiment stations are the oldest and most clear-cut of the research components of educational institutions. There is a station affiliated with a land-grant college in each of the 48 states and in each of the outlying parts. Federal grants for the support of the stations are of the order of 12 million dollars annually. In addition, the experiment stations can and do contract with federal agencies other than the Department of Agriculture's Office of Experiment Stations for research and development. In total, federal funds account for one-quarter of the funds available to the stations.

The need for a distinct research division has not been limited to agriculture, if one is to judge by the recent upsurge in the number of research affiliates of large universities. These organizations are devoted primarily to the conduct of organized research and may be within the legal framework of the institution, or may be separate entities with an interlocking governing board connecting them with the university. They may be functioning research organizations with their own staffs, or may serve simply as a negotiating agency to supervise the administrative aspects of the contract, while the research is performed by regular faculty members using the facilities of the institution proper. In 1951–52, 18 such research affiliates received a total of 2.9 million dollars.

The last of these components are the regular instructional departments of the institutions, which received 136 million dollars in 1951–52. The demarcation between this component and the others previously discussed, namely, the research center, the experiment station, and the affiliated organization, is obviously neither distinct nor emphatic. The difference between the different components is likely to be more a matter of administrative convenience than of substance. Admitting this, however, there is nevertheless a trend here which may portend significant consequences for the future, for it is fairly evident that there is a growing tendency toward a segregation in educational institutions of research activities from instructional activities. Although federal funds are by no means responsible for this development, they are very probably contributing to it.

Since this is only a factual report, it is not within its scope to discuss the policy implications of the data which have been presented. Obviously many questions are raised by the study. Is it desirable, for example, that such a large portion of funds for research and development at nonprofit institutions should be administered by agencies whose interests are primarily military? Is it desirable for educational institutions to operate research centers for the Government? Are there other techniques for handling this type of work? What are the consequences of concentration in a small number of institutions? To what extent should federal research and development funds be used to develop the research potential of smaller institutions? What are the long-run implications of the Government's emphasis on applied research and development in contrast to basic research? Does the difference between the amount of federal funds for work in the physical sciences and those in the biological and social sciences indicate a serious imbalance which should be corrected? What are the effects of the tendency toward formalization of research activities in educational institutions?

These and many similar questions are now receiving increasing attention and thought by individuals and by groups who are concerned with educational and research policies, both within and outside of Government. The National Science Foundation hopes that the factual study which has been summarized here and others of a similar character now projected will be helpful in solving such questions.

News and Notes

Scientists in the News

Roger Adams, Head of the Department of Chemistry, University of Illinois, spent last April in Madrid, attending the 50th Jubilee Anniversary meeting of the Spanish Chemical Society. In July he will receive the August von Hoffman Award of the German Chemical Society.

L. Earle Arnow, Director of Research, has been appointed a Vice President of the Sharp & Dohme Division of Merck & Co. Dr. Arnow came to Sharp and Dohme in 1942 from the University of Minnesota Medical School, and has been Director of Research since 1944. He is author or joint author with H. C. Reitz of two textbooks, *Introduction to Physiological and Pathological Chemistry* and *Introduction to Organic and Biological Chemistry,* respectively.

Robert L. Bennett has been appointed Medical Director of the Georgia Warm Springs Foundation. He has been Assistant Medical Director for many years, and is also Professor of Physical Medicine at Emory University School of Medicine.

H. O. Beyer of the Anthropology Department of the University of the Philippines, Manila, has been elected an honorary member of the Chicago Natural History Museum, an honor accorded to only eight other persons in the history of the Museum. Dr. Beyer is an international authority on the ethnology and archaeology of the Philippines.

Edward F. Degering, Secretary of the Chemistry Section (C) of AAAS, has resigned as Research Manager of Buckman Laboratories, of Memphis, Tenn., to accept the assignment as Chief, Branch of Chemicals and Plastics, of the Quartermaster Corps. Dr. Degering will be located in Washington, D. C., for about six months, and will move to Natick, Mass., as soon as the new research and development laboratory of the Quartermaster Corps is completed. Correspondence relative to the meeting of the chemistry section and its Boston program in late December, should be directed to: Edward F. Degering, Secretary, Chemistry Section, AAAS, George Washington Inn, New Jersey and C Sts., S.E., Washington, D. C.

Max Faucett of the Electrical Engineering Department, University of Illinois, will join the Illinois Power Company as Vice President at the end of this academic year. He has done notable work in power engineering, and headed the group which constructed the complex power network analyzer on the University campus.

C. C. Furnas, Director of Cornell Aeronautical Laboratory, served with a mission on a visit to the Long Range Weapons Establishment at Salisbury and Woomera, South Australia, in April and May. The trip was designed to review progress of the Australian Guided Missile Program, and Dr. Furnas served as representative from the Research and Development Board. He is Chairman of the Guided Missile Committee of the RDB.

Eddie M. Gordon has been appointed Medical Officer in Charge of the U. S. Public Health Service Hospital (National Leprosarium), at Carville, La. Dr. Gordon, formerly of the Chicago USPHS Hospital, succeeds **Frederick A. Johansen,** who is retiring after 29 years of service at Carville, and who participated in the development of sulfone therapy in the treatment of leprosy.

S. B. Hitchner of the Department of Veterinary Science, University of Massachusetts, and discoverer of the B^1 strain of Newcastle disease virus, has joined the research staff of the American Scientific Laboratories, Madison, Wis. Dr. Hitchner (U. Pa., V.M.D. 1943) has developed a widely known intranasal vaccine against Newcastle virus, isolated the agent causing infectious sinusitis of turkeys, and developed the spray method of vaccination against Newcastle disease.

As a member of the six-man International Abstracting Board of the International Council of Scientific Unions, **Elmer Hutchisson,** Dean of the Case Institute of Technology, will attend a meeting of the Board in Strasbourg, France, on July 6–7, 1953. Dean Hutchisson represents the International Union of Pure and Applied Physics.

Andrew C. Ivy, on leave of absence as Vice President in charge of the Chicago Professional Colleges, has been given the Leo XIII award for his contributions to medical science. The award was presented by Bishop Bernard J. Sheil of Chicago.

John F. McMillan, formerly chairman of the Department of Biology at the College of St. Thomas, St. Paul, Minn., has been appointed Professor and Chairman of the Department of Zoology at the University of Wichita.

David Marine, formerly Director of the Laboratory Division of Montefiore Hospital, New York, has received the 1953 Squibb Institute for Medical Research Award of the Endocrine Society, for his pioneering work in the physiology and chemistry of the thyroid gland. He was one of the first to demonstrate the correlation between endemic goiter and iodine deficiency in the diet. His experiments with iodine as a prophylactic agent made the control of endemic goiter possible throughout the world. Dr. Marine retired from the Hospital in 1945.

Herbert F. Moore, University of South Dakota Research Professor Emeritus in theoretical and applied mechanics, was honored April 25 by his alma mater, the University of New Hampshire. He received the New Hampshire Alumni citation for his achievements and for his contributions to society.

Hugh C. Muldoon, Dean of the College of Pharmacy, Duquesne University, will receive the Remington Honor Medal, pharmacy's highest award. It will be presented, probably in December, at a dinner meeting of the New York Branch of the American Pharmaceutical Association. This award was established by the New York Branch in 1918 and is given annually to the individual who has done most for American pharmacy in the previous year, or whose continuing contributions to the advancement of the profession have been outstanding. The jury of award called attention to Dr. Muldoon's service to the profession for several decades as an educator, author, and scientist and to his special contribution in the year just passed as Chairman of the Association's Committee on its Centennial Celebration in 1952. He is author of textbooks of organic chemistry and of pharmaceutical Latin, and editor of *The Science Counselor.*

Edwin D. Murphy and **Deane M. Chamberlain** have been appointed Research Associates at the Roscoe B. Jackson Memorial Laboratory at Bar Harbor. Dr. Murphy has been serving as a pathologist at the National Cancer Institute in Bethesda. His research will be in the field of tumor and general pathology, and he will be available to local physicians and hospitals for clinical work in blood and cancer patnology. Dr. Chamberlain, former Assistant Professor of Veterinary Pathology at the Ohio State University, will investigate diseases of animals in relation to heredity. He will also establish a local consultative practice in veterinary medicine. The total number of Research Associates, who are the senior scientists at the Labo-

ratory and hold a doctor's or equivalent degree, now stands at 33.

Ralph E. Peck, Professor of Chemical Engineering at Illinois Institute of Technology, has been appointed Director of the department effective September 1. Dr. Peck originally joined the staff in 1939 as an Instructor of Chemical Engineering. In 1951 he was one of a group of scientists who went to Costa Rica to do research designed to boost the production of Manila hemp and alleviate a possible shortage of that critical material.

Harold W. Schultz, head of two divisions for Swift and Company's research laboratories in Chicago, has been appointed head of the Food and Technology Department at Oregon State College effective July 1. He succeeds **E. H. Weigand,** founder of the department, who retired last July. Recently Dr. Schultz has received widespread recognition for his development of processed meats for babies.

Gordon Taylor has been appointed Assistant to the Director of the Connecticut Agricultural Experiment Station. He will be stationed in Windsor and will be in charge of the Station's Tobacco Laboratory. The Windsor Laboratory, heretofore set up as a separate Station Department, will now become a division of the Director's office. **Hendrik de Roo,** who receives his doctor's degree from the Agricultural University at Wageningen this June, has been appointed agronomist at the Tobacco Laboratory. He fills the vacany left by the resignation of **T. R. Swanback.**

Richard E. Warren has joined Libbey-Owens-Ford Glass Company as engineer in charge of the Electrical Section of the Engineering Department. Mr. Warren will work closely with plant personnel in maintaining existing electrical power for glass-making equipment and in planning new installation projects.

Virgil L. Weiser, range conservationist at the Bismarck headquarters of the U. S. Soil Conservation Service at Dickinson, has been appointed soils agent in the North Dakota Agricultural College Extension Service, Fargo. He will assist in the development of expanded services in soils, fertilizers, and crops.

Education

A unique group of graduate courses in geochronology and dendrochronology will be offered this summer at the **University of Arizona,** for students who are graduate majors in anthropology, botany, chemistry, or geology, and who have a background in statistics. Geochronology encompasses all scientific methods which can be applied to the dating of terrestrial events, and dendrochronology is concerned with the precise dating of events in years by means of tree-rings. Further information can be obtained from David L. Patrick, Dean of the Graduate College, or from Terah L. Smiley at the Laboratory of Tree-Ring Research, University of Arizona.

The Ohio State University will offer for the first time a graduate course in aviation physiology, to be given during the second term of the University's summer quarter, July 27–Aug. 28. H. E. Christensen of Stockholm, Sweden, will serve as visiting professor and will give approximately half the lectures. It is planned that staff members from the School of Aviation Medicine at Randolph Field, the School of Naval Aviation Medicine, Pensacola, and the Aero Medical Laboratory at Wright Field will also participate.

The thirtieth annual **Plant Science Seminar** will be held in Salt Lake City, Utah, Aug. 10–15. Joint sessions of the Plant Science Seminar and the Teachers' Seminar on Pharmacognosy and Related Subjects will precede the conventions of the American Association of Colleges of Pharmacy and the American Pharmaceutical Association by a week, and participants may sign up for both seminar week and convention week at the same time. Information is available from Dean L. David Hiner, College of Pharmacy, University of Utah, Salt Lake City.

Faculty members of the **University of West Virginia** who are retiring include Elizabeth M. Stalnaker, Professor of Psychology, William W. Downs, Professor of Civil Engineering, and George W. Grow, Associate Professor of Drawing and Machine Design. Dr. Stalnaker has served the University 28 years, Mr. Downs 22 years, and Mr. Grow 41 years, and all are graduates of the University of West Virginia.

Grants and Fellowships

Emory University has received a grant from Eli Lilly and Company in support of Francis Binkley's study of the chemistry and mode of action in insulin. Dr. Binkley is a professor in the Department of Biochemistry.

Three new **Guggenheim Fellows in Jet Propulsion** have been selected, and six previous fellowships have been renewed. The new fellows are Robert J. Hartlieb, Jr., of the Cornell Graduate School of Aeronautical Engineering, Saul Feldman, graduate student at UCLA, and David M. Benenson, of California Institute of Technology. The three will carry programs of advanced study and pioneering research at Caltech's Daniel and Florence Guggenheim Jet Propulsion Center. Fellows currently studying at Caltech who have had their grants renewed are: Odus R. Burggraf, Jr., Donald A. Dooley, Martin Goldsmith, Denver C. Gore, Jr., Frederick Harshbarger, and Charles A. Lindley.

Postdoctoral Fellowships in the Natural Sciences have been conferred upon four scientists by the **Lilly Research Laboratories of Indianapolis** through the National Research Council. The fellowships are available in sciences fundamental to the understanding of biological phenomena, especially in borderline fields between chemistry, biology, and physics. Recipients

of the fellowships and institutions at which they will study are: Howard M. Dintzis, Yale; Duane T. Gish, Medical College, Cornell; Howard E. Zimmerman, Harvard, and David S. Hogness, Institut Pasteur, Paris.

The **Yale School of Forestry** has received three grants totaling $210,000 to support research and fellowships for graduate study. The General Forestry Endowment Fund has received new contributions from nine companies. These gifts are part of a long-range campaign to raise $5,730,000 for enlarging the teaching and research program at the School of Forestry.

Meetings and Elections

The **American Geophysical Union,** at its recent annual meeting, unanimously passed the following resolution relative to science in government.

WHEREAS, It is of great importance to our country and to science that the work in its scientific agencies be carried on with both efficiency and integrity, be it

RESOLVED, That the American Geophysical Union believes that government scientific organizations should be staffed by high-caliber scientists, that these scientists should be permitted to conduct and report their investigations with scientific objectivity, and that the American Geophysical Union is opposed to all attempts to interfere with the work of scientific agencies for other than scientific motives.

Two events are scheduled for the near future by the **American Oil Chemists' Society.** The Fifth Annual Short Course, on the engineering aspects of oil seed processing, will be held at Texas A & M College, College Station, Tex., July 27–31. The 27th Annual Fall Meeting will be held in Chicago at the Sherman Hotel, Nov. 2–4. The Society's headquarters are at 35 E. Wacker Drive, Chicago.

The annual meetings of the **American Society of Agronomy** and the **Soil Science Society of America** will be held Nov. 16–20 at Dallas, Texas. An estimated 250 papers on developments in crops and soils will be presented, and the programs are open to anyone concerned with crop production and soil problems. H. E. Myers, Kansas Agricultural Experiment Station, Manhattan, is president of the A.S.A., and Eric Winters, Tennessee Valley Authority, Knoxville, is president of the S.S.S.A

The **Astrophysical Institute** of the University of Liège is organizing, under the auspices of the Belgian Institut Interuniversitaire des Sciences Nucléaires, a fifth in the series of Colloques Internationaux d'Astrophysique. This symposium, "Nuclear Processes in Celestrial Objects," will be held Sept. 10–12. Professor T. G. Cowling of the University of Leeds will preside. Papers will be grouped under three headings; 1, The Origin of the Elements, 2, The Internal Structure of Stars and Thermonuclear Reactions (hydrostatic models, evolution, questions of stability, etc.), and 3, The Cosmic Abundances of the Elements (observational data, isotope-ratios, radioactivity and age determinations, theoretical discussions). By way of introduction, each section will begin with a general review of the field. J. Podolanski and D. ter Haar, T. G. Cowling, and J. L. Greenstein have agreed to present reviews for sections 1, 2, and 3, respectively. Correspondence should be addressed to Dr. P. Ledoux, Institut d'Astrophysique, Cointe-Sclessin, Belgium.

The Fifth Annual **Oak Ridge Summer Symposium** will be devoted to modern physics, and will be held from August 24–29. The symposium will consist of lectures within the general fields of meson and ultra-high-energy phenomena, and electromagnetic radiations. Speakers will include: Jesse W. DuMond, California Institute of Technology; Ralph Livingston, J. Rand McNally, and T. A. Welton of the Oak Ridge National Laboratory; M. Stanley Livingston, MIT; and J. Steinberger, Columbia University. This will be the second in the series of summer symposia to be devoted to modern physics. The proceedings of the fourth symposium, held August 25–30, 1952, have recently been issued by the Technical Information Service of the Atomic Energy Commission, under the title "The Role of Atomic Energy in Agricultural Research." Additional information is available from the University Relations Division of the Institute, P.O. Box 117, Oak Ridge, Tennessee.

A nuclear technology institute was held at the **University of Wisconsin,** May 12–14, designed to present to engineering, managerial, research, and technical personnel from Wisconsin's industries a summary of current developments in the use of atomic energy for constructive purposes. Participants heard Farrington Daniels, Chairman of the Chemistry Department, describe the essentials and possibilities of a nuclear power reactor, and summarize some of the plans now being worked on in the development of a nuclear power reactor.

Miscellaneous

The new **Baltimore and Ohio Transportation Museum** will be formally opened at Baltimore on July 2, at the Mt. Clare Station, the oldest railroad station in the world. Eleven historic locomotives, wooden models of experimental locomotives constructed as early as the 18th century, a collection of road and trail vehicles beginning with a Mexican oxcart and including a Conestoga Wagon, and other items important in the development of transportation will be on display.

The **Chicago Natural History Museum** has opened a series of new exhibits on the Pomo Indians of central California. Most elaborate is a miniature diorama of a group of men and women collecting acorns, one of

the principal foods of the group. Games, jewelry, musical instruments, and digging sticks used in food gathering are on display. This exhibit completes the Hall of Plains, Intermountain, and California Indians at the Museum. George I. Quimby, Curator of Exhibits, was assisted in preparation of the hall by Alfred Lee Rowell, dioramist; Gustaf Dalstrom, artist; John Pletinckx, ceramic restorer, and Walter C. Reese, preparator.

Cuba and Ecuador have ratified the Convention of the **Inter-American Institute of Agricultural Sciences.** With these ratifications, Cuba becomes the thirteenth contracting country and Ecuador the fourteenth. The others are: Colombia, Costa Rico, the Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, the U.S., and Venezuela. The convention, which became effective in 1944, states that the purposes of the Institute are to encourage and advance the development of the agricultural sciences in the American Republics through research, teaching, and extension activities in the theory and practice of agriculture and related arts and sciences.

Three members of the **Lehigh University** faculty will retire on June 30. They are Merton O. Fuller, Associate Professor of Civil Engineering; Howard D. Gruber, Associate Professor of Electrical Engineering; and Lloyd L. Smail, Professor of Mathematics. Three other staff members were also honored by the University for 25 years of service; they were Charles W. Simmons, Professor of Chemical Engineering, Francis J. Trembley, Professor of Ecology, and Ralph N. Van Arnam, Assistant Professor of Mathematics and Astronomy.

The **National Association of Corrosion Engineers** has added a thirty-third and thirty-fourth section, in the region of the Pacific Northwest. The Association's Western Region Board of Trustees has approved formation of the Columbia River Basin Section and the newly organized NACE Canadian Region has approved formation of a British Columbia Section at Vancouver. Mark Adams of the State College of Washington will organize the Columbia River Basin Section.

The **National Science Foundation** has moved to a new location at 1520 H St., N.W., Washington 25, D. C. The new headquarters are in the old "Cosmos Club" building recently renovated by the General Services Administration. The new telephone number is Sterling 3-2140, and the mailing address will continue to be National Science Foundation, Washington 25, D. C.

Grants in the amount of $5266 have been received by **New York University-Bellevue Medical Center** from the American Cancer Society for cancer studies and research to be conducted by the NYU College of Medicine and the NYU Post-Graduate Medical School.

The University of Virginia has received a grant from Eli Lilly and Company in support of the work of W. Parker Anslow, Jr., on the mechanism of excretion of sulfur amino acids. Dr. Anslow is Chairman of the Physiological Laboratory, School of Medicine, University of Virginia.

An Owen H. Wangensteen Surgical Education Foundation, honoring the chief of the Department of Surgery, has been established at the University of Minnesota. The purpose of the Foundation is to promote advanced surgical education, and initial funds were donated by F. John Lewis, Richard L. Varco, and Charles E. Rea, of the faculty of the Department. Dr. Wangensteen will act as an adviser in administration of the funds.

Recent Deaths

Simon Albert (57), x-ray specialist, Providence, R.I., May 3; Sister Mary Angela (?), professor of mathematics and economics, Cleveland, May 17; Sir Robert G. Archibald (73), tropical medicine specialist, London, May 5; Arthur C. Bachmeyer (66), of Cleveland, physician, Washington, D.C., May 23; James Baird (80), of New York, construction engineer, Tucson, Ariz., May 16; A. L. Baker (55), engineer and designer of gaseous diffusion works, Summit, N.J., May 4; Ira L. Baxley (63), engineer, Elizabeth, N.J., May 11; William C. Benson, Jr. (31), design engineer, East Orange, N.J., May 24; Charles E. Birch (90), physician, Katonah, N.Y., May 11; David J. Bonawit (60), engineer, Loudonville, N.Y., Apr. 22; Herman Braloff (?), of New York, construction engineer, Rockville Centre, L.I., Apr. 24; William L. Bray (87), retired Dean of the Graduate School, Syracuse University, Syracuse, N.Y., May 25; Josiah Bridge (62), paleontologist, Washington, D.C., Apr. 30; Arthur Bright, Jr. (34), research economist, Boston, May 14; Lucius M. Bristol (81), sociologist, Gainesville, Fla., May 9; Charles S. Brown (68), inventor, Syracuse, N.Y., Apr. 22; Spencer W. Butler (54), construction engineer, Cleveland, May 26; Harold G. Calhoun (67), of New Canaan, Conn., political scientist, Athens, Greece, May 1; John J. Carson (64), chemical engineer, New Milford, Conn., May 11; Montgomery B. Case (71), bridge designer, Englewood, N.J., May 4; Paul W. Chapman (62), agricultural educator, Athens, Ga., Apr. 28; H. R. Charlton (74), gynecologist, Bronxville, N.Y., May 14; LaVerne E. Cheyney (42), of Detroit, analytical chemist, St. Paul, Minn., May 21; Benjamin F. Cohen (82), Moscow University mathematician, Moscow, May 9; Edward H. L. Corwin (67), public health authority, New York, May 8; Henry Crew (93), physicist, Evanston, Ill., Feb. ?; Leo T. Cribben (59), mathematician, Oswego, N.Y., May 2; John F. Cunningham (76), agricultural educator, Columbus, Ohio, Apr. 28; N. N. Dalton (?), research consultant to Glycerine Producers Association, Kansas City, Mo., Apr. 26; G. W. Davies (73), physician, Verona, N.J., May 24; Francis S. Denneen (73), industrialist and engineer, Cleveland, Ohio, May 11; Alexander G.

Dewey (62), political scientist, Brooklyn, N.Y., May 7; Joseph S. Diamond (72), of New York, specialist in internal medicine, Paris, Apr. 29; Carl E. Dreher (49), electrical engineer, Montclair, N.J., May 6; Benjamin F. Dubbels (50), of Pleasantville, electrical engineer, Mount Kisco, N.Y., May 18; Nadine P. Dudukaloff (73), bacteriologist, Scarsdale, N.Y., Apr. 22; Henry C. Earnshaw (72), physician, Philadelphia, May 22; W. Thurber Fales (59), health statistician, Baltimore, Md., May 21; Karl Fernstrom (65), educator and business engineer, Manhasset, L.I., May 6; L. C. Fischer (81), physician, Atlanta, Georgia, Apr. 29; Helen S. Fish (?), psychiatric social worker, New York, May 20; Emerson D. Fite (79), political scientist, Poughkeepsie, N.Y., May 17; Reginald Fitz (68), physician and educator, Brookline, Mass., May 27; Severn O. Fladness (63), Bureau of Animal Industry, Washington, D.C., May 5; Elsbeth E. Freudenthal (50), economist and author, New York, May 13; R. S. Gamon, Sr., of Camden, N.J., physician, Atlantic City, May 19; George H. Gleason (?), chemical engineer and industrialist, Montclair, N.J., May 25; Isaac J. K. Golden (81), physician, Chicago, May 19; John Good (68), inventor, Garden City, L.I., Apr. 29; Harold I. Grice (52), diabetes specialist, Schenectady, N.Y., Apr. 24.

William Hassig (78), senior scientist, Institute of Inter-Scientific Research, Chicago, April 29; Courtenay Headland (52), x-ray specialist, Yonkers, N.Y., May 26; Carl F. Holden (58), communications expert, Queens, N. Y., May 19; Rudolph W. Holmes (80), obstetrician and gynecologist, Chicago, Apr. 25; Elijah Jordan (79), professor, philosopher, and author, Indianapolis, Ind., May 18; Henry L. Lantz, conservationist and author of the Malta plan, Great Falls, Mont., May 9; Armin O. Leuschner (85), astronomer and professor, Berkeley, Calif., Apr. 22; Charles Lindmueller (78), chemist and tin expert, Chicago, May 3; John Lindsay (99), industrialist, helped Alexander Graham Bell with preparations for first long-distance call from Brantford to Paris, Ont., in 1876, Brantford, Ont., Canada, May 17; Warfield T. Longcope (76), professor and physician, Baltimore, Md., Apr. 25; B. B. Vincent Lyon (73), of Philadelphia, professor and internist, Washington, D.C., May 20; William L. Machmer (70), of Amherst and Wellfleet, mathematician, Wellfleet, Mass., May 24; Raphael Maglioni (62), archaeologist and priest, Hong Kong, China, May 27; Evelyn Stuart McNally Mason (47), psychologist, West Orange, N.J., May 18; Charles K. Maytum (57), physician and professor, Rochester, Minn., Apr. 10; Clinton P. McCord (72), neuropsychiatrist and psychoanalyst, Albany, N.Y., May 10; John J. McGrath (86), surgeon, Belmar, N.J., May 18; James W. McLaughlin (62), industrialist, New Rochelle, N.Y., May 15; Edward E. Minor (76), engineer and industrialist, New Haven, Conn., May 14; Gertrude Moore (69), pathologist, Oakland, Calif., May 3; Roy S. Moore, Sr. (68), of Syracuse, N.Y., physician, Fort Lauderdale, Fla., May 26; R. Andrew Nelson (48), physicist, Silver Spring, Md., May 10; William W. Nesbitt, of Seattle, Wash., medical officer of U.S. Public Health Service, Washington, D.C., May 7; F. Barnard O'Connor (61), civil engineer and industrialist, New York, May 26; Henry F. Offerman (86), minister and professor, Far Rockaway, Queens, L.I., May 21; Lee Ogden (65), chest specialist and professor, Greenwich, Conn., May 12; Carl Oman (63), electrical engineer, Cedar Grove, N.J., May 26.

Howard M. Parshley (68), zoologist, Northampton, Mass., May 19; Alfred H. Parsons (75), physician and surgeon, Sayville, L.I., May 3; Leo Pasvolsky (59), economist, Washington, D.C., May 5; Sydnor B. Penick (71), of Middletown and Montclair, N.J., drug executive, Montclair, May 24; Willett C. Pierson (77), chemical engineer, Yonkers, N.Y., May 13; Robert L. Praeger (87), naturalist and geologist, Belfast, Ireland, May 5; James B. Purcell (54), urologist and surgeon, Wilkes-Barre, Pa., May 13; Admiral Sir Robert Baikes (67), submarine specialist, Gloucester, England, May 23; John Reid, Jr. (66), of New York City, opthalmologist, Central Valley, N.Y., May 20; Walter A. Rex (35), of Westfield, N.J., chemical engineer, Plainfield, N.J., May 21; Heaton R. Robertson (72), engineer, Branford, Conn., May 9; Meyer Rosensohn (71), obstetrician and gynecologist, Larchmont, N.Y., Apr. 25; Franz X. Schaffer (77), geologist, Vienna, Austria, Apr. 17; Morris I. Schamberg (78), oral surgeon, Great Neck, L.I., May 20; Kristian Schultz (65), research engineer, Chicago, Apr. 22; Robert V. Seliger (52), psychiatrist and author, Baltimore, Md., Apr. 24; Walter B. Simpson (72), educator, East Orange, N.J., May 4; Hugh M. Smallwood (49), of Nutley, N.J., analytical research specialist in chemistry and physics, Newark, N.J., Apr. 27; Oliver M. W. Sprague, economist, Boston, Mass., May 24; Charles A. Stanley (74), missionary and educator, Claremont, Calif., Apr. 29; Henry B. Stoddard (73), lawyer, Fairfield, Conn., May 20; Neil J. Sullivan (55), construction engineer, Northampton, Mass., May 20; John D. Sumner (49), professor and economic adviser, Buffalo, N.Y., May 3; Mervyn R. Taylor (75), professor and physician, Philadelphia, Pa., May 1; Eleanor Ross Thomas (78), teacher and dean emerita, Middlebury, Vt., Apr. 27; Theodore C. Tuck (74), engineer and industrialist, New Rochelle, N.Y., May 21; Spencer A. Wahl (58), of Cleveland, Ohio, pediatrician, Bethesda, Md., May 21; Charles P. Watson (91), inventor of the slow-motion picture camera, Ventnor, N.J., May 15; William L. Weed (82), dentist, Norwalk, Conn., Apr. 28; Perley S. Wilcox (78), mechanical engineer and industrialist, Rochester, N.Y., May 17; Sven Winquist (76), industrialist and designer, Stockholm, Sweden, Apr. 17; Andrew Yeomans (45), of Norwich, Vt., physician and professor, Hanover, N.H., Apr. 17.

Technical Papers

The Stereoptometer—A Simple Haploscopic Instrument for the Study of Binocular Space Perception

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Fort Knox, Kentucky

In planning a series of basic studies of the functions operant in binocular stereoscopic range finding, the need for a relatively simple laboratory instrument was manifested. The requirements appeared to be that the instrument (*a*) approximate the visual tasks of the operator of a binocular stereoscopic range finder; (*b*) be as psychologically simple as possible (e.g., be without the complexities introduced by optical and/or base magnification or minification); (*c*) be adaptable to use both in controlled laboratory situations and in actual field situations.

Of the three types of classical instruments available (haploscopic, stereoscopic, and Howard-Dolman rods), a haploscopic-type instrument was considered most appropriate because of the similarity in the visual tasks presented by such an instrument and by a binocular stereoscopic range finder. Specifically, in both tasks the observer is presented with a "simulated" reticle field for comparison with an actual field of view.

In the instrument developed, the reticle field is provided by two USAF reflex gun sights. The reflex sight (see the schematic presentation in Fig. 1) consists of a source of illumination (A), a diffusion glass (B), a reticle disk (C) placed at the focal point of a Mangin mirror (D), and a half-reflecting surface (E). The Mangin mirror transforms the divergent light rays from the pattern cut in the reticle disk into parallel beams of light. The half-reflecting surface reflects these parallel beams to the eye, while at the same time allowing transmission to the eye of light (F) from the field of view. To an observer looking through the reflex gun sight, the reticle image appears to be located at some indefinite distance in the "real" field.

In a pilot model stereoptometer (Fig. 2) constructed at the Psychology Department of the Army Medical Research Laboratory, two reflex sights (S) are used. One (S-1) is mounted rigidly to a base; the other (S-2) is mounted on a bearing which allows rotation in a horizontal arc. The tangent of the angle of rotation of the one sight with respect to the other is found by use of a thousandth-inch dial gage measuring from a point calibrated as being 9.060 in. from the center of the point of rotation. As the movable sight is rotated through a given angle (e.g., the angle represented by a change in the tangent from A-1 to A-2), the point of intersection of the extensions of the two

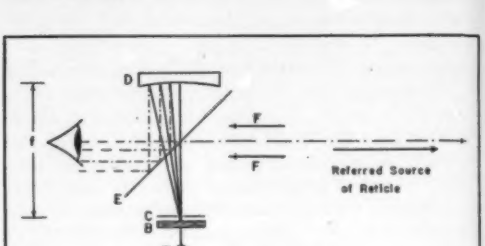

FIG. 1. Schematic diagram of a reflex sight.

reticle beams from the reflex sights is changed accordingly (e.g., from R-1 to R-2). A range, the distance from the fixed sight (S-1) to the point of intersection, is determined by appropriate trigonometric calculations. These calculations follow the formula: Range = (9.060)(IBE)/(gage reading), where the IBE is an interpupillary base estimate for the observer. With the gage reading expressed in inches, the range will be expressed in the same units as the IBE.

The instrument provides for two types of ranging tasks through the use of fused and unfused reticle fields. When the reticle patterns used are similar to the extent of allowing fusion by the observer into a single reticle image, and when the left and right reticle beams are adjusted to yield no vertical displacement, the ranging task becomes one of true stereoptic acuity (i.e., vergence of the right reticle beam results in phenomenal movement of the single fused reticle image in depth). In this case, the on-target condition occurs with the phenomenal alignment of the reticle image with the target in the depth dimension. When, however, the reticle patterns used in the reflex

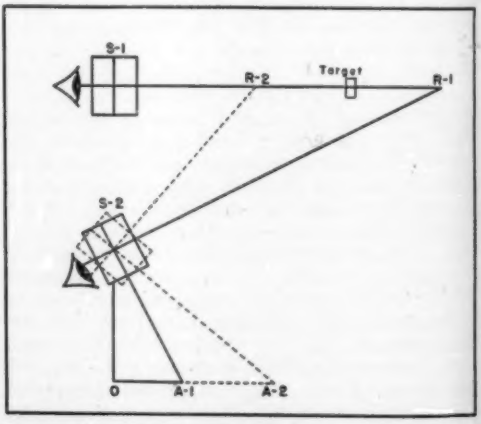

FIG. 2. Schematic diagram of a stereoptometer.

sights are dissimilar to the extent of preventing fusion, or when the left or right reticle beam is adjusted to yield a vertical displacement between the two reticle images, the ranging task may become one of either binocular summation or interocular vernier acuity (i.e., vergence of the right reticle beam results in phenomenal movement of the right reticle image in the right-left dimension only). The on-target condition in this case occurs while fixating the target with the phenomenal achievement of the particular geometric configuration used (e.g., the vertical alignment of the two reticle images of the two vertically displaced reticle beams).

It may have been noted that the instrument described above provides for vergence of the right reticle beam only. With such asymmetrical vergence, the fused reticle image in the stereoptic task appears to move obliquely from far-right to near-left, and vice versa. Were the left reticle beam the verging system, this apparent motion would be on a near-right to far-left oblique, whereas with symmetrical vergence the fused reticle image would appear to move radially in depth. It would seem desirable to have an instrument which would provide symmetrical vergence of both reticle beams as well as asymmetrical vergence of either. Such an instrument is under construction at this laboratory.

Manuscript received November 6, 1952.

Studies on the Uricase Activity of Rats Fed *p*-Dimethylaminoazobenzene

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An attempt was made in this paper to investigate the uricase activity of rats in the course of liver-cancer production by *p*-dimethylaminoazobenzene (butter yellow) feeding. The rats were fed *p*-dimethylaminoazobenzene for 120 days by the method of Kinoshita (*1*). This was continued for an additional 2–3 weeks with the basal diet free from the dye. After this both sexes of 14 albino rats were killed by exsanguination within a week. The livers were classified macroscopically according to the suggestion of Nakahara *et al.* (*2*) into four groups: macroscopically normal, uneven surface, cirrhotic, and liver cancer. As a control group, both sexes of 10 albino rats were fed with basal rice diet. Water intake was ad libitum and green vegetables were supplied twice a week.

To estimate the uric acid consumed, Benedict's direct method was adopted. Enzyme solution was prepared as follows. A piece of liver tissue, weighing exactly 1 g, was ground in a mortar and thoroughly extracted with 10 ml of borate buffer solution (pH 8.5), and centrifuged at 3000 rpm for 5 min. To 0.5 ml of this extract, 2 ml of borate buffer containing 0.4 mg of uric acid and 20 ml of borate buffer was added. After adding 0.5 ml of toluene, each test tube was stoppered tightly and incubated at 37° C for 6 hr. After the incubation, to 5 ml of this solution was added 4 ml of 1/12 *N* sulfuric acid, and 0.5 ml of 10% sodium tungstate solution (Folin-Wu's precipitation method), in succession, after which the solution was filtered. To 5 ml of the filtrate, 4 ml of sodium cyanide solution and 1 ml of arsenophosphotungstic acid was added, the test tube was placed in a boiling water bath for 3 min, and it was then left at room temperature for about 2 min and finally subjected to photocolorimetry.

TABLE 1

URICASE ACTIVITY OF THE LIVER OF RATS IN THE COURSE OF LIVER CANCER PRODUCTION (37° C, 6 HR).

Liver findings	No. of examples	Uric acid consumed (mg %)*	Uricase activity†
Normal liver (controls)	10	0.312 (0.276–0.369)	100
Experimental group macroscopically normal liver	10	0.390 (0.356–0.432)	125
Uneven surface liver	4	0.357 (0.285–0.414)	114
Cirrhotic liver	6	0.294 (0.227–0.359)	94
Liver cancer	6	0.072 (0.041–0.098)	23

* Figures given as averages and ranges.
† Value for normal taken as 100.

All data are summarized in Table 1. It is clearly seen in the table that the degrees of uricase activity of the livers which showed macroscopically normal and uneven surfaces were 125 and 114 respectively, whereas the activity of the normal liver reached just 100. The uricase activity of the cirrhotic liver was 94, and that of the liver cancer was only 23. This indicated that the uricase activity of rat liver was evidently increased when the pathological change in the liver was not recognized or not remarked. But, when the liver tissue became cirrhotic, the uricase activity became less remarkable than the above and almost the same as normal. It is noteworthy that when the liver tissue became cancerous, the uricase activity dropped to only a quarter of normal.

Conclusions. It was demonstrated that the uricase activity of rat liver increased once at the early stage of liver change and then decreased at the cancerous stage in the course of liver-cancer production. Uricase contains iron in the molecule as catalase does. Drastic decreases in the activity of catalase of mice and rats by tumor implantation were demonstrated by several workers (*3*), especially Greenstein (*4, 5*). And the significance of this enzyme has become more prominent in cancer research since the discovery of toxohormone by Nakahara and Fukuoka, who have shown that the extraction of a fraction with low molecular weight from tumors which, when injected intraperitoneally, lowered liver catalase activity of normal mice (*6, 7*).

One of the authors reported (*8*) that the liver catalase has the same influence on the activity as the uricase described above in the course of carcinogenesis. Uricase is found only in the liver tissue of mice and rats. No investigation of uricase has ever been demonstrated in the research in experimental cancer production.

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Manuscript received November 13, 1952.

Circulatory and Autonomic Factors in Bulbar Facilitation and Inhibition of Reflexes[1]

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New Orleans, Louisiana

The close association of autonomic effects and bulbar and diencephalic facilitation and inhibition of the patellar reflex has been pointed out previously (*1–4*). It appeared desirable to determine whether bulbar facilitation bears any relation to the well-known Orbeli phenomenon, which involves enhancement of the muscular contraction evoked by direct motor nerve stimulation when the sympathetic supply to the muscle is simultaneously stimulated.

Cats were anesthetized with Nembutal (30 mg/kilo) and were prepared as illustrated in Fig. 1. In some experiments only one hind limb was used, and in other experiments both hind limbs were prepared as follows. Steel pins were drilled into the extremities of the femur so that a very rigid fixation of the limb could be arranged. The iliopsoas muscle was sectioned, and the saphenous and sartorius branches of the femoral nerve and the whole sciatic trunk and its hamstring branches were divided. In one leg the quadriceps branch of the femoral nerve was also sectioned to provide a distal stump for direct stimulation of the motor nerve to the quadriceps muscle by means of shielded electrodes. The other limb was so arranged that the knee jerk could be recurrently elicited by a rhythmically actuated solenoid.

The reticular formation of the brainstem, the posterior hypothalamus, and the mesencephalon was explored with stereotaxically oriented concentric electrodes. Stimuli consisted of 60-cps pulses of approximately 10-sec duration with a strength of 5–10 v. The femoral motor nerve-quadriceps muscle preparation was rhythmically stimulated through the distal stump of the nerve by means of 0.1-v sine wave applied at the rate of 1/sec. Blood pressure, when recorded, was taken from the carotid artery, and drug infusions were administered through in-dwelling needles in the external jugular vein. The femoral artery and adrenal veins were exposed for clamping, the lumbar sympathetic chains were loosely ligated for later avulsion, and the upper lumbar cord was exposed through the dura and a loose ligature applied for later severance at L1.

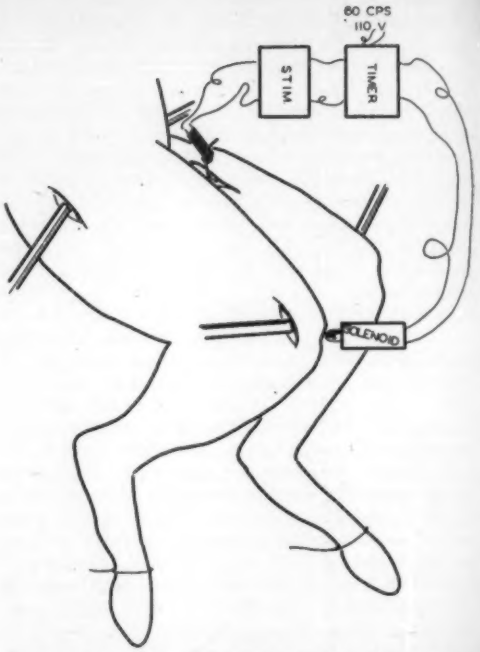

FIG. 1. Schemata of cat preparation. Both hind limbs are rigidly fixed by steel pins drilled into the extremities of the femurs. A rhythmically actuated solenoid activates the patellar reflex on one side which has been completely denervated with the exception of the quadriceps branch of the femoral nerve. The other side has been completely denervated, and the distal stump of the quadriceps branch of the femoral nerve is enclosed in shielded electrodes which recurrently stimulate the motor nerve fibers.

The first experimental procedure attempted was to determine the effect of surgical interference with the sympathetic supply to the limb on bulbar facilitation of the knee jerk. Figure 2A shows mesencephalic facilitation of the knee jerk, and Fig. 2B shows abolition of the response after bilateral resection of the lumbar sympathetic chains and clamping of both adrenal veins. The second procedure involved pharmacologic interference with sympatholytic drugs subsequent to, during, and preceding bulbar facilitation of the knee jerk. Figure 2C shows bulbar facilitation

[1] Supported by a grant from the Louisiana Heart Association.

[2] With the technical assistance of S. M. Olivier.

of the knee jerk accompanied (in this instance) by a vasopressor response. Figure 2E shows considerable reduction of the degree of bulbar facilitation and of the vasopressor response (although not complete abolition of either) after the intravenous infusion of 1% Dibenamine.[3] Comparable effects following the infusion of 1% Tolserol (Myanesin)[4] in a different preparation are shown in Fig. 2F. It is worthy of note here that Myanesin not unexpectedly abolishes the vasopressor response as well as the bulbar facilitation of the patellar reflex because both processes undoubtedly involve multineuron activation. Figure 2D, from a different preparation, shows the abolition of an initial facilitation, following the infusion of 1% ergotoxine, comparable to that shown in Fig. 2A.

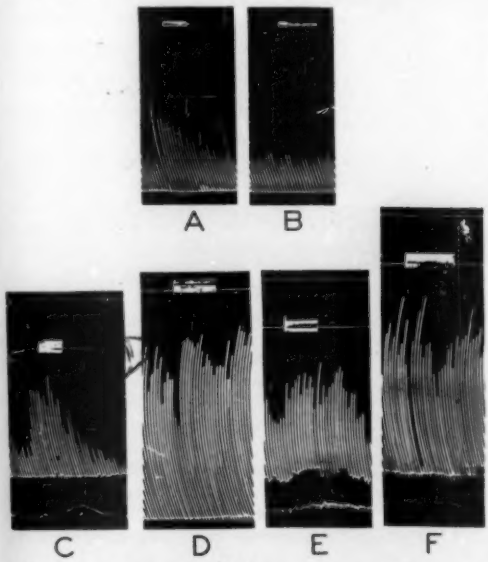

FIG. 2. A. Mesencephalic facilitation of the patellar reflex (5 v). B. Mesencephalic facilitation of the patellar reflex (5 v) after resection of both lumber sympathetic chains and occlusion of both adrenal veins. C. Bulbar facilitation of the patellar reflex (and pressor response) (2 v). D. Same as C in a different preparation without blood pressure record during infusion of 0.1 cc 1% ergotoxine. E. Same preparation as in C during infusion of 0.6 cc 1% Dibenamine. F. Same as C but different preparation during infusion of 1 cc 1% Tolserol (Myanesin).

The necessity for complete interference with the sympathetic supply to the limb in order to produce abolition of facilitation is shown by the following. Figure 3A illustrates hypothalamic facilitation of the knee jerk which is depressed but not abolished by resection of both lumbar sympathetic chains (Fig. 3B). Subsequently the adrenal veins were compressed bilaterally with the unusual result, shown in Fig. 3C,

[3] The Dibenamine was generously provided by Smith, Kline and French Laboratories.

[4] We are grateful to E. R. Squibb and Sons for making Tolserol available to us.

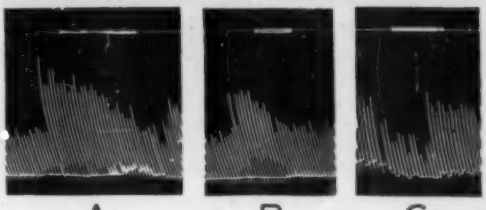

FIG. 3. A. Hypothalamic facilitation of the patellar reflex (2 v). B. Same as A except that lumbar sympathetic chains have been cut. C. Same as B except that in addition both adrenal veins have been clamped.

that the previous facilitation was converted into an inhibition. This result is not typical, the common effect simply being an absence of faciltation.

These results suggest that bulbar facilitation of the patellar reflex might well represent central activation of the Orbeli phenomenon analogous to the *piqure diabetes* first described by Claude Bernard (*5*). In order to test this hypothesis bulbar facilitation of the recurrently elicited knee jerk was obtained as shown in Fig. 4A, and then the isolated femoral motor nerve-quadriceps muscle preparation isolated *in situ* from the central nervous system was rhythmically activated at the same frequency as the knee jerk. Stimulation of the bulbar source of knee jerk facilitation apparently enhanced the contraction of the nerve-muscle preparation as shown in Fig. 4B but it is not certain that this effect is entirely free of stimulation artifacts. Intravenous administrations of adrenalin have also caused an enhancement in both knee jerk and nerve-muscle preparations to the same extent.

Inhibition of the patellar reflex has also been investigated in the same fashion. After bulbar inhibition of the knee jerk was obtained, the cord was sectioned at L1 by tying a thread through the cord and removing the knotted ligature. The bulbar inhibitory effect was again sought. The effect persisted in spite of the fact that all nervous connections between the brain-

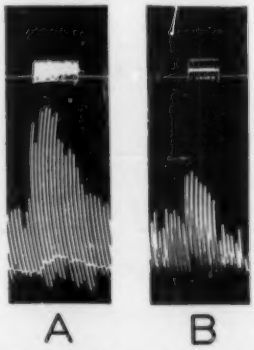

FIG. 4. A. Bulbar facilitation of patellar reflex (5 v). B. Same preparation as A; bulbar facilitation of opposite femoral motor nerve-quadriceps muscle preparation recurrently activated by 0.1 v.

stem reticular formation and the cord site of the patellar reflex are had been severed. Post-mortem examination of the cord showed complete severance. This inhibitory effect has been obtained in 3 preparations. It is characterized by inconsistency of elicitation; and it is at no time so strong, so complete, or so rapid in appearance as when the cord is intact. Occlusion of the femoral artery may depress bulbar inhibition of the patellar reflex, decrease the degree of inhibitory after-discharge, and increase the extent of "escape" from prolonged bulbar inhibitory stimulation.

It appears obvious from these results that bulbar facilitation of somatic reflex activity involves the production of adrenalin and the activation of the sympathetic supply to the limb. It is not yet clear that such facilitation precludes any additional or substitutive facilitatory mechanisms in the orthodox sense at the site of the patellar reflex arc within the cord. It is apparent that the sympathetic system and adrenalin liberation may be activated by stimulation of the bulbar reticular facilitatory system in such a fashion as to resemble a *piqure d'Orbeli* in the Bernardian sense (*5*). The presence of some circulatory factor in the bulbar inhibitory phenomenon also seems apparent, but the nature of this effect is as yet obscure.

Ever since Orbeli's first report on the effects of adrenalin on neuromuscular fatigue (*6*), various investigators have reaffirmed and extended his original findings. Thus Corkill and Tiegs (*7*) showed that both adrenalin and sympathetic stimulation would enhance the height of muscular contraction, and Gruber (*8–10*) has shown that adrenalin enhances muscular contraction, delays the onset of fatigue, and introduces significant variations in the time relations of various phases of muscular contractions. Tuttle (*11*) claimed that adrenalin increased the tonus of the quadriceps and of the patellar reflex. Recently Bülbring and Burn and collaborators have carried out intensive and significant investigations concerning the mode of action of adrenalin on neuromuscular and central nervous system activity (*12–16*). Their results indicate that the phrenic nerve-diaphragm preparations show an increased tension duration to maximal stimulus volleys due to the direct action of adrenalin on the muscle fiber. They also find that flexor and extensor movements induced by descending motor tract stimulations can be depressed or enhanced under different circumstances by adrenalin, and that nerve action potentials may be enhanced by a non-circulatory effect of intra-arterially injected adrenalin. From additional evidence that adrenalin may enhance transmission at the neuromuscular junction in the phrenic nerve-diaphragm preparation, they conclude that adrenalin may increase the nerve-muscle response in three ways: (1) to a minor extent by augmenting the contraction of the muscle fiber itself; (2) by improving neuromuscular transmission; and (3) by improving excitability and conduction in the motor nerve fiber. It is tempting to draw the conclusion that the effects described here constitute a central nervous system activation of the effects described by Bülbring and Burn, but much work remains before this point can be confirmed.

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On the Use of Calomel Half Cells to Measure Donnan Potentials

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Since their use by Loeb (*1*), calomel half cells have been widely employed in measuring interface potentials that arise between suspensions of charged colloids and solutions of electrolytes with which they may be in equilibrium (i.e., Donnan potentials). In making these measurements it has been commonly assumed that no junction potential exists at the KCl saturated bridge which is inserted in the suspension. Recently, this assumption has been questioned by Jenny *et al*, (*2*) who interpret their data to mean that the junction potential may be appreciable. This has led the present writers to re-examine the assumption that two calomel half cells can measure a Donnan potential even if one explicitly assumes that the transference numbers of K^+ and Cl^- are equal.

In order to predict the emf which will result from the insertion of electrodes into any system, the proper procedure is to write down each individual process that occurs when n faradays pass through the circuit in question, to add these processes and to obtain the net cell reaction. The emf for the cell is then given by,

$$\Delta F = -nF_y E_{cell}$$

where F_y is the faraday. This procedure is applied below to the classical model of a Donnan system.

Assume that a suspension of potassium colloid, KR, (phase I) is in equilibrium with a solution of KCl (phase II) across a membrane permeable to KCl but not to colloid. The equilibrium condition is:

$$a_{(KCl)}{}^{(I)} = a_{(KCl)}{}^{(II)}$$

We now inquire whether calomel half cells with salt bridges can measure an interface potential which may exist across the membrane (Donnan potential).

Let us insert calomel half cells with saturated KCl bridges. The cell is

$$\mathrm{Hg} \,\Big|\, \mathrm{Hg_2Cl_2} \,\Big|\, \underset{(\mathrm{sat})}{\mathrm{KCl}} \,\Big|\, \overset{\mathrm{A}}{\underset{\mathrm{KCl+KR}}{\mathrm{I}}} \,\Big|\, \overset{\mathrm{M}}{\underset{\mathrm{KCl}}{\mathrm{II}}} \,\Big|\, \overset{\mathrm{B}}{\underset{(\mathrm{sat})}{\mathrm{KCl}}} \,\Big|\, \mathrm{Hg_2Cl_2} \,\Big|\, \mathrm{Hg}$$

We shall assume that the transference numbers of K^+ and Cl^- are equal across boundaries A, B, and M.

In order to obtain the net cell process, we must write the electrode reactions and the transference processes at the interfaces *A*, *M*, and *B* and obtain their sum. When 2 faradays pass, the following processes occur:

$$\begin{array}{lll}
(a) & \mathrm{Hg_2Cl_2} + 2e^- & \rightarrow 2\mathrm{Cl^-}\,(\mathrm{I}_s) + 2\mathrm{Hg} \\
(b) & \mathrm{K^+}\,(\mathrm{I}) + \mathrm{Cl^-}\,(\mathrm{I}_s) & \rightarrow \mathrm{Cl^-}\,(\mathrm{I}) + \mathrm{K^+}\,(\mathrm{I}_s) \\
(c) & \mathrm{K^+}\,(\mathrm{II}) + \mathrm{Cl^-}\,(\mathrm{I}) & \rightarrow \mathrm{Cl^-}\,(\mathrm{II}) + \mathrm{K^+}\,(\mathrm{I}) \\
(d) & \mathrm{K^+}\,(\mathrm{II}_s) + \mathrm{Cl^-}\,(\mathrm{II}) & \rightarrow \mathrm{K^+}\,(\mathrm{II}) + \mathrm{Cl^-}\,(\mathrm{II}_s) \\
(e) & 2\mathrm{Hg} + 2\mathrm{Cl^-}\,(\mathrm{II}_s) & \rightarrow 2e^- + \mathrm{Hg_2Cl_2}
\end{array}$$

The subscript *s* denotes that the ion in question is in the salt bridge so that (*b*) corresponds to the transfer of 2 faradays from bridge I to solution I, (*c*) corresponds to the transfer of 2 faradays across the membrane, and (*d*) corresponds to the transfer of 2 faradays from solution II to bridge II. Adding the processes we obtain the net cell reaction,

$$\mathrm{KCl}\,(\mathrm{II}_s) \rightarrow \mathrm{KCl}\,(\mathrm{I}_s)$$

That is, the net process is simply the transfer of KCl between the two bridges. The ΔF for this process must be zero since KCl is transferred between solutions of the same composition, and hence $E_{cell} = 0$. This same result is obtained even when the transference numbers across the membrane are not the same. If the transference numbers of K^+ and Cl^- across the membrane are t_+ and t_-, then the net cell process becomes,

$$(2t_+ - 1)\,\mathrm{KCl}\,(\mathrm{II}) + \mathrm{KCl}\,(\mathrm{II}_s) \rightarrow (2t_+ - 1)\,\mathrm{KCl}\,(\mathrm{I}) + \mathrm{KCl}\,(\mathrm{I}_s)$$

Since the activity of KCl is the same in I as in II at equilibrium, we again find $\Delta F = 0$ and $E_{cell} = 0$.

We are led to the conclusion that if an emf is measured for the cell in the laboratory, the assumption of equal transference numbers at either *A* or *B* or both must be in error. When the transference numbers are not equal at the bridge junction, this means that there is a net transfer of salt from the bridge to the suspension. This transfer is the driving force of the cell, and it cannot have a ΔF which is the measure of the membrane potential, since, as may be demonstrated experimentally, its magnitude depends upon the salt concentration in the bridge.

The arguments above show that even where transference numbers at the KCl bridges are assumed to be equal, the calomel half cell assembly does not measure the membrane potential in a Donnan system. Therefore, if an emf is obtained experimentally for such a cell, it must mean that the transference numbers are not equal at at least one of the bridge junctions. In other words, the nonequilibrium bridge junctions are the only possible seat of an emf.

This finding is in accord with the statements of Gibbs and later of Guggenheim who emphasized that it is impossible to measure interface potentials. However, this is not to deny the probability that such interface potentials may exist. In certain kinds of membrane systems interface potentials can be estimated from theory, provided that the solutions are sufficiently dilute.

The foregoing approach has been extended and applied to membrane systems of other types (permselective membranes). A more complete discussion will be published soon.

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The Mucolytic and Digestive Action of Trypsin in the Preparation of Sputum for Cytologic Study[1]

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Cytology is, at the present time, the most promising approach to the problem of early morphologic diagnosis of lung tumors. The most serious limitation to its widespread application has been the lack, heretofore, of a satisfactory means of concentrating the cellular material found in sputum. As a result, it has been necessary for the pathologist or laboratory technician to select, by macroscopic inspection, a very small proportion of the total specimen for microscopic examination.

This method of selection is unavoidably influenced by chance. Nasal and oral materials are always present in sputum; if the amount of true bronchial sputum is minimal, it may be entirely overlooked in the selection of material for screening.

It is now believed that a negative cytological report is not justified unless at least 15 slides have been studied. When 15 slides, from 5 different sputum samples are examined, an accuracy of approximately 92% can be achieved (*1, 2*). If for any reason this series is not complete, accuracy falls off sharply. A satisfactory method of concentration, it is hoped, would not only increase over-all accuracy, but reduce the number of sputum samples required as well, and thus considerably expedite diagnosis.

[1] The trypsin used in this study was Tryptar, kindly furnished by the Armour Laboratories, Chicago, Illinois.

Previous approaches to the problem. It is impossible to centrifuge cellular elements out of sputum because of the viscosity of the medium. Hyaluronidase liquefies the mucus in the sputum, but the process is too slow to be feasible (*3*). The proteolytic enzyme, papain, activated by cysteine, is rapid enough in its action, but the residual precipitate markedly obscures cellular detail (*4*). Another enzyme, the "receptor-destroying" enzyme recovered from filtrates of *vibrio cholera,* as suggested by the work of Burnet and Stone (*5, 6*), and a mucolytic agent, lysozyme (*3*), have also been found unsatisfactory.

Agents other than enzymes have been investigated. Urea and sodium bicarbonate were shown to reduce the viscosity of mucus, but they also cause severe distortion of cell structure (*3*). An ingenious attempt to precipitate the mucus by lead acetate, in conjunction with differential centrifugation, likewise failed to give reasonably dense concentration of cellular material (*3*).

Trypsin in the treatment of sputum. Trypsin is chiefly known for its selective enzymatic digestion of nonviable organic material (*7, 8*). Since the bulk of cellular material in sputum is mature, nonviable squamous cells, normally exfoliated in great numbers from oral mucosa, it was thought that this action of trypsin might be useful in the preparation of specimens of such secretions. By reducing the number of such cells, it might speed the screening process, and increase the number of specimens that could be evaluated daily by the limited number of trained personnel available. Since trypsin, moreover, is known to have substantial mucolytic action, it was decided to aim at a method by which both the digestive and mucolytic actions could be utilized. We believe that such a technique has been achieved.

Technique for the use of trypsin. Early in this work it became apparent that the mucolytic action of trypsin affected sputum only when the mixture was simultaneously heated and vigorously agitated. A Kahn shaker provides suitable agitation, but we have been unable to devise a method of supplying controlled heat with this method. At present, we are using manual agitation with frequent heating under a tap of running warm water.

Another method, using commonly available equipment, has been found satisfactory. Heat is supplied by a serological water bath regulated to 57° C, and the agitation force is supplied by air pressure from a portable compression tank. The tank attachment has multiple faucets which are connected by rubber tubing to glass droppers inserted into centrifuge tubes containing the sputum and trypsin mixture. Pressure is regulated to a forceful stream. Results with this method have been satisfactory, although further experience may indicate a more simple approach.

We have found that 125 mg (125,000 Armour units) of trypsin, dissolved in 12.5 ml of Sörensen's buffer (pH 7.1), is sufficient to liquefy from 8–10 ml of sputum. The sputum and trypsin, in this proportion

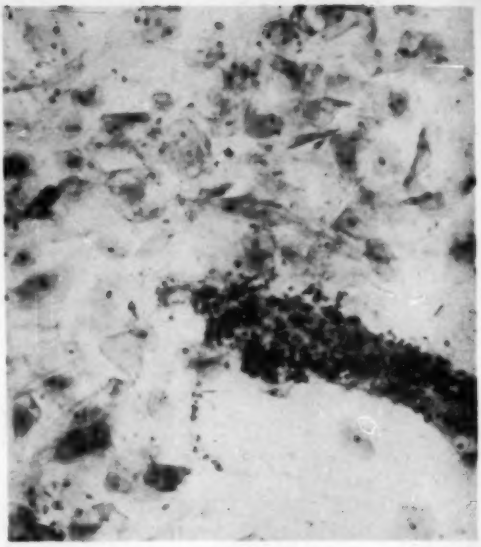

FIG. 1. Before tryptic digestion. Numerous mature squamous epithelial cells and fibrinous strands. × 100.

FIG. 2. Same specimen following tryptic digestion. Marked decrease in both squamous cells and fibrin resulting in a thin, homogeneous film of discrete cells. × 100.

are put in a centrifuge tube with a capacity of 2–3 times the total amount of the mixture, so that subsequent agitation will generate sufficient force to break up and dissolve the tenacious strands of mucus and fibrin. One or two drops of caprylic alcohol, depending upon the agitation time, reduces the surface tension,

and thus prevents foaming which commonly occurs when protein solutions are agitated.

The time required to liquefy a specimen thoroughly depends upon its initial viscosity, but the most tenacious specimen usually responds within 15 min. After the specimen has been agitated, a small amount—0.5–1 ml—of human plasma is layered to the bottom of the centrifuge tube with a pipet or capillary dropper. This plasma accomplishes two ends. First, plasma acts, to some extent, as an inhibitor of trypsin activity (*9*) and is a convenient substance to use for arresting the digestive process. Secondly, it acts as an adhesive agent in the subsequent procedures, replacing the liquefied mucus. Unless some such substance is added, cells are readily lost from the slide during fixing and staining.

Results. The evaluation of the mucolytic effect of trypsin was made upon the basis of stained smears made of the sediment recovered after centrifuging. The best criteria of such an effect, we believe, are the homogeneity of the smear, the appearance of the stained cellular elements, and the absence of cell clumps and fibrinous strands of cells. In terms of such criteria, the mucolytic action of trypsin was entirely satisfactory and distinctly superior to the action of any other mucolytic agent we have investigated. In a series of smears made at 5-min intervals (in terms of digestion time), we observed complete disappearance of fibrinous strands and cell clumps, with markedly homogeneous smears at the end of 15 min. There was no further change in the appearance of smears until after 50 min of agitation and digestion when a suggestion of overdigestion, evidenced by a reduction in sharpness of cytoplasmic borders and the appearance of numerous ghostlike fragmentary structures, was noted. These changes were progressively heightened as the agitation and digestion time was increased.

The effectiveness of trypsin in reducing the number of mature, nonviable squamous cells was marked. This was determined by comparing slides prepared with trypsin-treated material with slides from the same sputum specimens which were processed in the usual manner. The apparent effect is a substantial increase in the number of macrophages on the slide made from trypsin-treated material (Figs. 1 and 2), but there has, in fact, been a substantial reduction in the number of mature squamous cells. Trypsin does not alter the standing characteristics of cellular material; all cells maintained their usual reaction to Papanicolaou staining.

Trypsin had no noticeable effect upon the appearance of malignant cells. In comparison with routinely processed material, however, the concentration of malignant cells in the trypsin series was notable. It was estimated that smears prepared by this method contained from 4–6 times as many malignant cells as slides made in the usual way from the same sample of sputum. It is also important to note that malignant cells from an adenocarcinoma do not lose, in the process of being concentrated, their distinctive clumping—an important criterion in evaluating this type of malignancy.

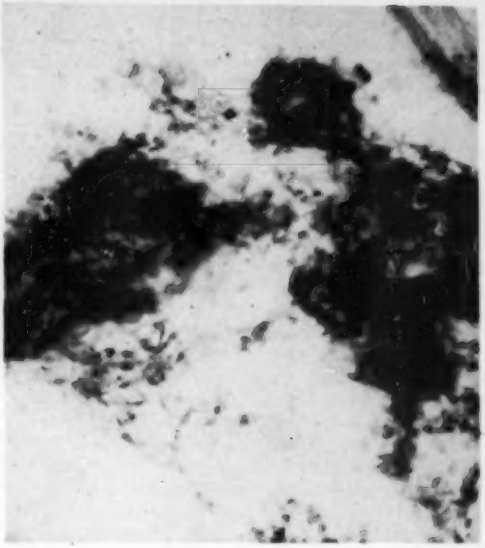

FIG. 3. Overdigestion with trypsin. Large clusters of malignant squamous cells. Other cellular elements appear as an amorphous debris. × 100.

In short, the use of trypsin, as described above, appears to be a practical and feasible answer to the problem of concentrating the cellular elements of sputum,

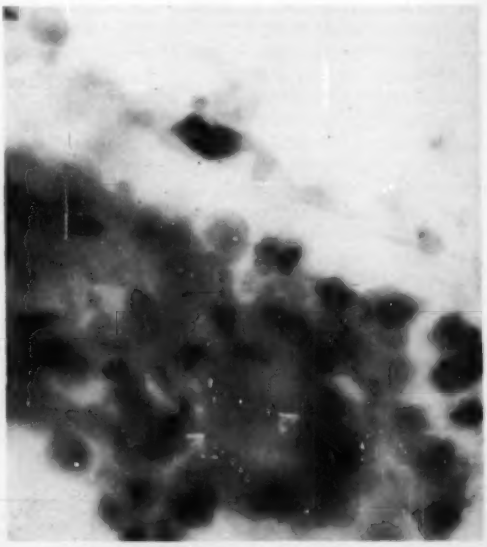

FIG. 4. Higher magnification of Fig. 3, revealing preservation of malignant cellular detail. × 430.

and in addition, it eliminates approximately 60% of the material which is not significant to diagnosis. In almost every case, all cellular material available from a specimen of sputum could be smeared on one or two slides. This technique has not been in use long enough for accurate evaluation, but there is every reason to hope that a substantial increase in efficiency will be achieved, as well as an increase in accuracy of diagnosis.

Overdigestion phenomenon. A specimen collected from a patient with a known epidermoid carcinoma of the lung and coexisting tuberculosis was overdigested by 1½ hr exposure to trypsin in a running tap-water bath of aproximately 60° C. Stained slides made from the sediment, as was expected, revealed a background of hazy, nondescript cell fragments. Quite unexpectedly, however, numerous malignant cells were seen in an excellent state of preservation and appeared in large clumps. The nuclei of these malignant cells retained their typical dense hyperchromicity and the cytoplasm remained brilliantly orange, as is usual for the highly cornified malignant squamous cells (Figs. 3 and 4).

This phenomenon needs careful evaluation, but it suggests the possibility of a radically new approach to cytology in all its phases. If this observation is confirmed, trypsin could be of great service in the cytologic diagnosis of gastric cancer, where the number of oral squamous and other nonsignificant cells are a great problem. It might be useful as a vaginal douche in cases where it is impossible to obtain satisfactory smears by the usual technique because of postradiation fibrinous and nonviable debris. Trypsin might also be used to lyse clotted pleural and ascitic fluids for cytologic study and, in sufficient concentration, to digest the abundant fecal debris from lower bowel and rectal washings, and thus permit cytologic study of such material.

Summary. By the addition of a solution of trypsin, thick, tenacious sputum can be liquefied and concentrated without loss of significant cellular detail. This compound also digests most of the mature squamous cells which normally make up a large proportion of the cellular elements in sputum, as well as other nonviable materials. As a consequence, it is generally possible to smear all significant cellular material upon only one or two slides. Cell structure is at least as clearly visualized as by the older method, and in the case of pulmonary malignancy the number of malignant cells which can be seen on the slide is enormously increased.

Overdigestion with trypsin was employed on a limited number of specimens. It was found that malignant cells remained intact and easily identifiable after all other cells in the specimen were obliterated by enzymatic digestion.

The utilization of the digestive action of trypsin in the preparation of materials other than sputum for cytologic study has many possibilities, although study of a larger number and variety of cases is necessary before a definite conclusion is warranted as to the range of applicability of this method.

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2,3,5-Triphenyltetrazolium Chloride as a Rapid Indicator of Viability in Cottonseed

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Use of 2,3,5-triphenyltetrazolium chloride for the rapid detection of viability in seeds, first proposed by Lakon (*1*), is based on the capacity of the stain to dye only those parts of the seed embryo that are alive and will grow (*2–5*). The stain, colorless in aqueous solution, is reduced to a red insoluble formazan in the presence of living tissue upon which it is deposited (*4*). A number of investigators have applied this staining technique to cottonseed for the detection of viability, with limited success. Flemion and Poole (*6*) used whole excised embryos and observed a light staining of the entire embryo or most of it. Their results seemed to agree substantially with Flemion's rapid viability test (*7*) in which excised embryos are germinated on moist filter paper in Petri dishes at room temperature. Raggio and de Raggio (*8*) reported results with tetrazolium chloride in good agreement with germination tests. Poe *et al.* (*9*), using whole kernels and an infrared lamp to apply heat and accelerate the reaction, reported that the tetrazolium chloride test agreed with the standard germination tests in only 57% of the individual samples examined. They concluded that the stain could not be relied on to give accurate results for routine laboratory experi-

[1] Appreciation is expressed for assistance in some of the experiments from Miss E. A. Jensen, N.C.P.A. Fellow, and Mrs. J. S. Lambour; and to James B. Dick, Delta Branch Experiment Station, Stoneville, Miss., and Wales Newby, Cotton Oil Products Co., Inc., Opelousas, La., for furnishing the seed. The author acknowledges the helpful suggestions of A. M. Altschul during the preparation of this manuscript.

[2] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry Agricultural Research Administration, U. S. Department of Agriculture.

ments. Porter *et al.* (*10*) tested longitudinal sections of the whole seed after a presoaking period, but encountered "hard seed" (seed that did not imbibe water) and mechanical difficulties that prevented an accurate evaluation of the color test.

Since the results in the literature were not in agreement, Porter's (*10*) method was selected as most suitable for adaptation since it incorporated one of the more desirable features, that of exposing a longitudinal section of the embryo to the stain. It was modified to obviate the difficulties which he reported and then applied to untreated seed and seed that had been heat-treated, exposed to high energy cathode rays, and stored in a sealed container for several weeks. When available, graded series of samples, consisting of decreasing numbers of viable seeds to increasing numbers of nonviable seeds, were tested. Data are presented which indicate the possibility of using the modified method for rapidly detecting the germinating capacity of cottonseed. Each time the staining technique was applied, the results were compared with those from the standard germination test (*11*) on seed drawn from the same lot.

The following modifications in Porter's (*10*) technique were made. A stronger solution of the stain, 2%, was used. The lint and coat were removed from the kernel since it had been observed that they did not react with the dye. "Hard" seed were excluded from these investigations because Porter found that they did not react. As small a volume of staining solution was used as was required to insure a reaction between it and the cut surface of the section. It was found undesirable to cover the seed section with the stain as there was a tendency for the cottonseed embryos to float and the various parts of the section to separate when an excess of indicator solution was used. Precautionary measures were observed to insure that the cut surface was exposed only momentarily to the atmosphere and that while in contact with the stain both stain and tissue were constantly protected from the light. Differences in the depth of color and the extent to which the cut surface of the tissue became stained were noted.

Small portions of heat-treated samples of cottonseed from other experiments were made available for the tests reported here. They had been heated in a steam-jacketed Baker-Perkins mixer[3] which had been modified to heat rapidly and mix uniformly without crushing approximately 2000-g samples (*12*). Portions of samples from series exposed to increasing dosages of high energy cathode rays (*13*) were also subjected to the tetrazolium chloride staining technique. The cathode rays were produced by a pressure-insulated, electrostatic generator of the Van de Graaff type, operating at 3 million v and capable of emitting a continuous supply of monoenergetic electrons in a magnetically focused beam (*14*).

[3] The use of trade names in this article is for identification and does not imply endorsement by the Department of Agriculture of this product over similar products not mentioned.

All lots of cottonseed were presoaked in distilled water for 16–18 hr. Then 200 seeds from each lot (unless otherwise indicated in the tabulated data below) were sectioned longitudinally approximately through the center of the radicle. Only those embryos that were sound in appearance were exposed to the tetrazolium chloride solution. During the sectioning operation, discolored and soft embryos and empty and shriveled seeds were discarded. The lint and coat were removed from the kernel and half of the kernel was placed, cut-side down, in a Petri dish located in a dark compartment and containing a 2% aqueous solution of the indicator. (The stock dye solution was never more than 4 weeks old and was stored in the dark.) One hundred kernel halves could be accommodated conveniently in one Petri dish which, when full, was placed in a dark cabinet at room temperature during the incubation period of 24 hr.

Complete staining of the sections could be observed in 4 hr. A check count, made after 24 hr, always agreed with the 4-hr count. In some samples, particularly those that had been heat-treated, distinct variations in the depth of color and its location were recognized. Considering all the samples 4 different reactions were observed. They were: (1) an intense carmine red coloring of the entire cut surface; (2) a faint but complete staining of the section; (3) a partial reaction in which cotyledons were stained wholly or in part, but radicals were unaffected by the stain; and (4) no reaction in any portion of the section.

It was first determined that the reaction between the cottonseed kernel and 2,3,5-triphenyltetrazolium chloride was heat labile, as was the case with many other tissues (*15, 16*). Prime fuzzy seed (Delfos 651 variety, 1948 crop), boiled for 15 min, did not reduce the stain, whereas 95% of the unboiled seed from the same lot stained readily. Comparably 95% of the unboiled seed germinated, but none of the boiled ones sprouted during the standard test. When kernel sections from both lots of seed were immersed in tetrazolium chloride solution in the same Petri dish, the boiled seeds were easily distinguishable from the unboiled ones after 4 hr. After 24 hr, counts in duplicate groups of 100 sections each remained unchanged indicating that the formazan once formed and deposited on the tissue did not diffuse into the solution or become deposited on those sections that had not reacted in 4 hr. This exploratory experiment demonstrated that tetrazolium chloride could be used to distinguish between viable and nonviable cottonseed.

Duplicate sets of a lot of naturally moist cottonseed (Delfos variety, 1950 crop, 14% moisture content) were heated at 160° F for 10, 20, and 30 min. The results of the standard germination test and the rapid staining method are shown in Table 1. Observed were seed sections entirely unstained, a few in which only the radicle remained unstained, a substantial percentage that were faintly though completely colored pink, and those intensely stained a carmine red in all parts. When compared with the values obtained from

TABLE 1

CHANGES IN VIABILITY OF HEAT-TREATED COTTONSEED* AS SHOWN BY THE TETRAZOLIUM CHLORIDE AND THE STANDARD GERMINATION TESTS

Duration of heat treatment (min)	Seed discarded (%)	Response to tetrazolium chloride test				Standard germination test (%)
		None (%)	Partial (%)	Completely stained Faint (%)	Completely stained Intense (%)	
0	30.5	3.5	—	6.0	60.0	52.8
	26.5	11.5	—	—	61.5	56.5
10	31.5	2.0	3.5	19.5	43.5	42.7
	25.0	1.5	0.5	2.5	70.5	61.0
20	22.7	36.7	—	36.7	3.8	2.8
	22.0	21.0	—	46.0	11.0	1.2
30	59.5	14.0	—	26.5	0.0	0.0
	19.0	41.0	—	38.0	2.0	0.5

* Delfos variety, naturally moist, of 14% moisture content, crop year 1950, grown at the Delta Branch Experiment Station, Stoneville, Miss.

TABLE 2

REDUCTION IN VIABILITY OF COTTONSEED* STORED† IN A SEALED CONTAINER AS SHOWN BY THE TETRAZOLIUM CHLORIDE AND STANDARD GERMINATION TESTS

Storage (weeks)	Seed examined (no.)	Seed discarded (%)	Response to tetrazolium chloride test			Standard germination test (%)
			None (%)	Completely stained Faint (%)	Completely stained Intense (%)	
None	100	24.0	6.0	41.0	29.0	50.3‡
3	408	34.0	36.3	21.8	7.8	7.5

* Mixed variety, 1950 crop, naturally moist, of 20% moisture content.
† Storage in a cabinet maintained at 80° F for 3 weeks.
‡ Average of duplicate tests of 400 seeds each.

TABLE 3

CHANGES IN VIABILITY OF A DELFOS 651 VARIETY OF COTTONSEED IRRADIATED WITH CATHODE RAYS* AS DETECTED BY THE TETRAZOLIUM CHLORIDE AND THE STANDARD GERMINATION TESTS

Dosage (rep†)	Seed examined (no.)	Seed discarded (%)	Response to tetrazolium chloride test		Standard germination test (%)
			None (%)	Completely stained Intense (%)	
None	92	10.8	30.4	58.8	66.7‡
500,000	97	10.3	33.0	56.7	47.2
1,000,000	100	10.0	73.0	17.0	8.5
1,500,000	170	7.0	92.9	0.0	0.0
2,000,000	190	1.0	99.0	0.0	0.0

* High voltage cathode rays produced by a Van de Graaff type generator operating at 3 Mev.
† Rep = roentgen equivalents physical as described by Evans (*21*).
‡ Only 75 seeds available.

standard germination tests, it appeared that those seeds that had reacted completely to give an intense red color could be considered viable.

A sample of naturally moist cottonseed of 20% moisture content was stored in a pint-size sealed glass jar at 80° F for 3 weeks. Germination counts by the standard method showed that during the interval germinability had been reduced from 50.5 to 7.5%. Only 7.6% of the stored seed stained intensely red when exposed to the tetrazolium chloride solution (Table 2). In this sample of seeds staining was complete when it occurred and was either faint pink or intense red. None of the seeds stained heavily in one part of the embryo and lightly in another.

When it was found that increasing dosages of high-voltage cathode rays had adverse effects on the germination and growth of cottonseed (*13*), small samples of the irradiated and unirradiated seeds were examined by the staining technique. The results (Table 3), when compared with those obtained by germinating the seed according to the standard test, indicated again that the seed sections intensely stained could be considered viable. It was interesting to note that there was either an intense response or no reaction. Apparently, loss of reducing capacity took place throughout the entire seed. This might be interpreted as evidence that penetration of the rays was complete when it occurred.

The pH of cottonseed has been found to range between 6.4 and 6.7 (*17, 18*). Hence, complete staining to an intense red cannot be attributed to the presence of reducing sugars which react with the stain only above pH 11 (*19*) nor to that of ascorbic acid, cysteine, and glutathione which react only above pH 9 (*20*).

The fact that the percentage of sectioned embryos which stained completely an intense red showed close agreement with the percentage of normal sprouts obtained by the standard germination test in 16 out of 17 lots of seed indicates that any reaction other than the complete staining to an intense red can be interpreted as a loss of the capacity of the seed to germinate. This close association between the results of the two methods has led to the conclusion that the tetrazolium chloride test when conducted as described, offers promise as a rapid means of detecting changes in viability of cottonseed.

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Effect of Intravenously Injected Bone Marrow Cell Suspensions on Thymic Regeneration in Irradiated C 57 Black Mice[1]

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The development of thymic lymphomas in systemically irradiated C 57 black mice is effectively inhibited by placing a lead shield over one thigh during exposure, despite the fact that the thymus receives the same x-ray dose (*1, 2*). It was recently shown that, although initial radiation injury to the thymus is not prevented, thymic regeneration is significantly accelerated by thigh shielding (*3*). This report is concerned with a series of four experiments indicating that this effect of thigh shielding may be largely reproduced by intravenous injection of homologous bone marrow cell suspensions into systemically irradiated mice. Regeneration of the thymus begins less promptly, however, and requires the injection of relatively large amounts of bone marrow. The intraperitoneal implantation of skeletal muscle and the intravenous injection of exogenous thymic cell suspensions were not effective in promoting thymic recovery.

In each of the four experiments, littermate C 57 black mice of both sexes, aged 33 ± 3 days at the start of treatment, were distributed equally among 3–6 groups. These groups included both untreated and irradiated controls and four types of experimental groups. The irradiated controls received an intravenous placebo injection of Locke's solution, 0.05–0.10 cc, promptly after each of 4 periodic total-body doses of 168 r each at 8-day intervals, on experimental days 1, 9, 17, and 25. Physical factors were: 120 kvp, 9 ma, 0.25 mm Cu + 1.0 mm Al added filter, 30 cm mouse-target distance, 32 r/min. Experimental groups were similarly irradiated and treated in one of the following ways: (*a*) lead shielding of one thigh during each irradiation, as previously described (*2*); (*b*) intravenous injection of bone marrow cells suspended in Locke's solution; (*c*) intravenous injection of thymic cells similarly suspended; and (*d*) intraperitoneal implantation of minced skeletal muscle. The bone marrow suspensions were freshly made each time according to the method of Lorenz *et al.* (*4*). In most instances, the suspension injected into a single recipient contained the femoral marrows of a single young C 57 black donor (1 : 1 concentration), but in one experiment the femoral marrows of each two donor mice were divided among 5 recipients (2 : 5 concentration).

One group of donor animals received 1–4 periodic x-ray exposures (168 r) at 8-day intervals with both thighs shielded by a lead strip 1 cm wide and 3 mm thick. The shielded femoral marrow was removed promptly thereafter, suspended, and injected intravenously (1 : 1) into a correspondingly irradiated recipient. Skeletal muscle from the shielded thighs of the same donors was minced, and small fragments were loaded into trocars for implantation. Thymic cell suspensions were made by mincing thymuses of untreated donors in Locke's solution; they were injected intravenously in 1 : 1 concentration.

At predetermined intervals from 1 to 26 days after the last irradiation (experimental days 26–51), corresponding groups were sacrificed. The thymus, spleen, and pooled superficial lymph nodes (2 axillary, 2 inguinal) were rapidly excised, dissected free of fat and connective tissue, weighed on a torsion balance, and preserved in Bouin's fluid for histologic study.

The mean thymic weights of all groups are summarized in Table 1, and those of the control, marrow-injected, and thigh-shielded groups are compared in Fig. 1. Thymic weight recovered rapidly in the thigh-shielded groups and again overshot normal levels by day 51. The thymuses of animals given marrow cell suspensions began to regenerate appreciably later (day 33), but their rate of recovery thereafter roughly paralleled that of the thigh-shielded groups. The irradiated controls receiving Locke's solution alone showed a slight abortive rise in thymic weight between days 29 and 33, after which there was a secondary fall to initial post-irradiation levels which persisted through day 51. The differences between the mean thymic weights of the marrow and placebo-injected groups are significant at the 0.05 level at day 33 in one experiment, and again at day 40, and become increasingly great thereafter.

Marrow cell suspensions in 2 : 5 concentration did not significantly affect thymic weights at days 33 and 45, nor were muscle implants or thymic cell suspensions effective at day 51. In additional studies, preirradiated (450 r) marrow-cell suspensions were ineffective at day 29, but normal marrow cell suspensions were equally so at this time. "Stimulated" marrow from the femurs of thigh-shielded, irradiated

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TABLE 1

THYMIC WEIGHT IN IRRADIATED C 57 BLACK MICE

Expt. day	Day 26	Day 29	Day 33		Day 40	Day 45	Day 51	
Days after last irradiation	1	4	8		15	20	26	
Expt. no.	IV	I	II	IV	IV	II	III	IV
No. mice/group	(7–8)	(9–10)	(4)	(6–8)	(7–8)	(5–6)	(7–8)	(6–8)
No x-ray; age controls	—	56.7 ± 2.5*	—	—	53.0 ± 4.3	—	44.8 ± 1.8	47.9 ± 3.2
X-ray + Locke's solution I.V.	15.7 ± 0.5	13.6 ± 1.1	29.6 ± 2.4	24.2 ± 1.4	22.2 ± 1.4	18.2 ± 0.9	20.3 ± 0.7	16.7 ± 0.8
X-ray + marrow I.V. 2:5	—	—	22.1 ± 0.9	—	—	20.7 ± 2.0	—	—
X-ray + marrow I.V. 1:1	17.4 ± 1.0	15.4 ± 0.8	29.9 ± 3.1	32.1 ± 2.9	31.6 ± 4.3	34.9 ± 3.8	46.3 ± 5.8†	39.6 ± 4.3
X-ray with thigh shielded	14.7 ± 0.7	—	—	42.3 ± 3.1	49.0 ± 3.8	—	66.7 ± 1.8	65.6 ± 3.6
X-ray + muscle implant I.P.	—	—	—	—	—	—	22.4 ± 5.0	—
X-ray + thymic cells I.V.	—	—	—	—	—	—	25.9 ± 4.1	—

* Mean and standard error by $\sqrt{\frac{\Sigma(\bar{x}-x)^2}{n(n-1)}}$.

† Marrow taken from shielded donor femurs immediately after 1–4 periodic irradiations.

donors was not significantly more effective at day 51 than normal marrow. Perhaps the interval between such irradiation and the time of sacrifice must be increased to permit the shielded marrow to express an enhanced proliferative or regenerative capacity. There was no correlation between body weight and thymic weight in any of the irradiated groups. Body weight in the irradiated groups was significantly lower than in the controls and was not affected in any systematic manner by any of the treatments employed (Table 2).

Lymph node weights were markedly reduced by irradiation in all groups, and recovered more slowly than those of the spleen and thymus. Mean lymph node weights of the thigh-shielded and marrow-injected groups were significantly greater than those of the placebo-treated groups at day 51, but not earlier. There was no consistent effect of treatment on spleen weight.

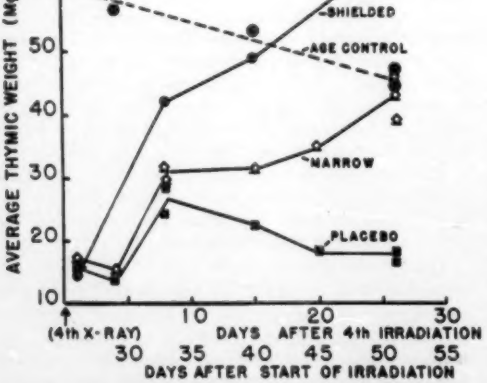

FIG. 1. Comparative effects of thigh shielding and intravenous bone marrow cell suspensions on thymic regeneration in C 57 black mice.

Histologic studies indicated an equal degree of initial radiation injury in thymus, nodes, and spleen of all groups. At day 40, there was much variation among the irradiated-placebo thymuses, some of which still showed marked cellular depletion and poorly defined cortical-medullary boundaries. Those of the marrow-injected mice, though still somewhat smaller than normal, were more uniformly restored to virtually normal architecture, and the thymuses of the thigh-

TABLE 2

Expt day	Expt no.	Treatment	Mean body wt ♂	Mean body wt ♀	Mean thymic wt
40	IV	Controls, no x-ray	23.4	19.4	53.0
		X-ray + Locke's solution	21.5	18.7	22.2
		X-ray + marrow I.V.	19.8	18.4	31.6
		X-ray + thigh shielding	20.3	17.6	49.0
51	III	X-ray only	22.8	19.1	23.2
		X-ray + Locke's solution	22.2	18.0	20.3
		X-ray + marrow I.V.	21.6	19.2	46.3
		X-ray + muscle I.P.	21.1	18.5	22.4
		X-ray + thymic cells I.V.	22.1	18.8	25.9
		Controls, no x-ray	24.7	23.1	44.8
		X-ray + thigh shielding	22.0	17.5	66.6
51	IV	Controls, no x-ray	23.8	20.0	47.9
		X-ray + Locke's solution	22.2	17.5	16.7
		X-ray + marrow I.V.	22.8	18.8	39.6
		X-ray + thigh shielding	22.0	18.3	65.6

shielded animals were larger and still more advanced in this respect. There appeared to be a greater degree of extramedullary hematopoiesis at days 40 and 51 in the red pulp of the irradiated-placebo spleens than in those of the other two groups. However, regeneration of the Malpighian corpuscles of the thigh-shielded and marrow-injected groups was evident distinctly earlier than in the irradiated-placebo controls.

It appears that intact bone marrow cells, whether autologously present in the shielded femurs of irradiated mice or injected into unshielded animals from homologous donors, may in some way facilitate regeneration of radiation-damaged lymphoid tissues

and, in particular, of the thymus. This phenomenon may explain in part the protective effect of homologous marrow cell suspensions and activated ectopic marrow against lethal doses of irradiation in mice and rats (*4, 5*). In view of the inhibitory effect of thigh shielding on the development of radiation-induced lymphoid tumors, it seems reasonable to predict that a similar, though perhaps less pronounced, inhibition of this neoplastic process will be observed after injection of exogenous marrow cells into irradiated mice.

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The Interaction of Genetic and Environmental Influences Affecting the Incidence of Avian Leucosis

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There is some doubt whether the various forms of avian leucosis, such as neural, visceral, and ocular lymphomatosis, erythroblastosis and granuloblastosis (the last two are uncommon), can be induced by a single virus, or whether several different viruses are involved, but there is agreement among pathologists and poultrymen that the disease is the most serious one afflicting domestic fowls today.

Most mortality from leucosis occurs between 2 and 16 months after hatching. In that period deaths from this disease may reach 50% or more. Recent tests of about 3300 severely exposed female chicks representing 36 different, improved strains showed that about 20% died of neoplasms (nearly all leucosis) before reaching 500 days of age (*1*).

In the light of present knowledge, the most important factors determining the mortality from leucosis in any exposed flock seem to be (*a*) the genetic constitution of the birds, (*b*) the age at which they are exposed, and (*c*) the severity of that exposure. This last apparently depends in part upon environmental conditions still unknown. It is the purpose of this note to show how these 3 factors interact and how knowledge of that interaction can be used to attain a satisfactory measure of control.

(*a*) Genetic resistance to leucosis has been studied continuously by the writers for the past 18 years. The feasibility has been demonstrated of breeding strains of White Leghorns capable of high egg production and so resistant that, when severely exposed to leucosis, mortality from that disease is almost negligible. Previous reports (*2, 3*) showed that deaths from neoplasms among these birds up to 500 days of age in 3 successive years, 1944–46, varied only from 5–8% in unculled flocks. In the birds hatched in 1951, mortality from leucosis alone (excluding other neoplasms) in that same period among 2177 females of the C- and K-resistant lines was only 2.7%, but it was 61% for birds of the susceptible strain. These had been mixed with the others since hatching and even during that process.

(*b*) The relation of age to susceptibility became clear when different investigators showed independently that chicks not genetically resistant to leucosis, when reared in complete isolation until about 5 months of age, are then highly resistant when brought to infected premises (*4, 5*). Subsequent experiments in which chickens reared in isolation, and hence presumably uninfected, were taken at various ages to infected quarters showed that most of this resistance had been developed by 10–16 weeks (*6, 7*) and in some cases even at 6 weeks (*8*) or 30 days (*9*). The utilization of this knowledge for control of the disease has been difficult, and in most cases impracticable, because few poultrymen can afford to maintain a separate, isolated establishment for rearing their birds.

(*c*) The severity of natural exposure varies greatly from flock to flock within any one area, from year to year in any one flock, and even from one weekly hatch to the next at any one farm. Among environmental factors that might contribute to this variability, only one has been clearly incriminated, namely, the proximity of the chicks to adult fowls during the critical first few weeks after hatching. During 3 successive years, deaths from neoplasms (mostly lymphomatosis) up to 500 days of age among birds that had been brooded only 40 feet from adult stock were 1.6–4 times as numerous as in full sisters that had been brooded over 100 feet from older birds (*10*). Although that difference in environment, with its accompanying difference in severity of exposure, was maintained only during the critical first 13 days from hatching, after which all chicks were kept on the same rearing range until 5 months old, it proved to be the deciding factor (apart from genetic resistance) in determining the amount of mortality from leucosis in these birds at later ages.

The relation of these three interacting factors—inheritance, age at exposure, and severity of exposure—to mortality from leucosis is clearly revealed in Fig. 1, which shows the mortality from that disease in the 4 annual generations of our White Leghorns raised in the years 1948–51. All females alive at 6 weeks of age are included, and, for simplicity, those of the 2 resistant strains are shown as a single group.

In 1948, 1949, and 1951, chicks exposed right after hatching apparently underwent the usual severe exposure desired to facilitate selection, and, as a result, mortality from leucosis in the susceptible strain ranged from 51–64.5%. Among birds of the resistant strains, which had been brooded, raised, and maintained with the others, corresponding mortality was only 2.7–7.8%.

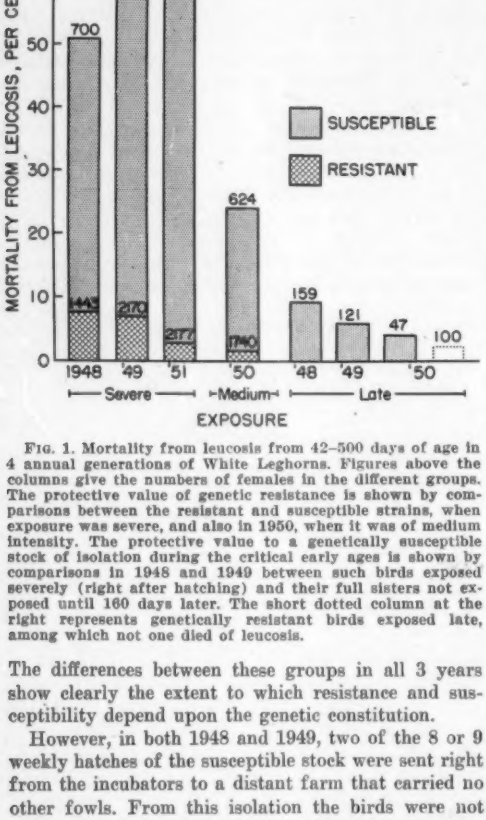

FIG. 1. Mortality from leucosis from 42–500 days of age in 4 annual generations of White Leghorns. Figures above the columns give the numbers of females in the different groups. The protective value of genetic resistance is shown by comparisons between the resistant and susceptible strains, when exposure was severe, and also in 1950, when it was of medium intensity. The protective value to a genetically susceptible stock of isolation during the critical early ages is shown by comparisons in 1948 and 1949 between such birds exposed severely (right after hatching) and their full sisters not exposed until 160 days later. The short dotted column at the right represents genetically resistant birds exposed late, among which not one died of leucosis.

The differences between these groups in all 3 years show clearly the extent to which resistance and susceptibility depend upon the genetic constitution.

However, in both 1948 and 1949, two of the 8 or 9 weekly hatches of the susceptible stock were sent right from the incubators to a distant farm that carried no other fowls. From this isolation the birds were not returned to infected premises until about 160 days old. With that comparatively late exposure, mortality from leucosis was reduced to 9.4% in one year and 5.8% in the next. Comparison of these low figures with the corresponding high ones for full sisters severely exposed in the same 2 years shows how protection by isolation during the critical early stages of life will reduce subsequent mortality to a comparatively negligible minimum, even in a stock that is genetically highly susceptible. Details of these experiments were given elsewhere (*11*).

In 1950 mortality from leucosis was only 23.9% in the susceptible strain and 1.5% in the resistant ones. That the exposure of these chicks to the causative agents had been of only medium intensity was obvious, but the reasons for it were not. Conditions under which the birds were brooded and reared (*i.e.*, the exposure) did not differ in any recognizable way from those of other years. Any possibility that the strains had undergone radical changes genetically seems unlikely because (*a*) mortality was simultaneously reduced in all 3 strains below the levels of previous years, and (*b*) in 1951 it was restored to a more normal 61% in the susceptible line.

Such inexplicable variations from year to year in the severity of exposure, along with similar differences between chicks hatched early and those hatched late in the same season, constitute some of the difficulties confronting those who study the etiology of avian leucosis. While it is desirable in genetic studies to eliminate such variation by inoculating all birds with a standard dose of the pathogen, attempts to do so have thus far failed because response to artificial inoculation apparently gives little or no measure of familial differences in susceptibility to infection through normal channels (*12, 13*).

With the medium exposure in 1950, the difference in mortality between the different stocks was greatly reduced, and the protective value of genetic resistance was correspondingly less evident. As in the 2 previous years, some birds of the susceptible stock were reared in isolation, but a change was made by sending with them chicks of the resistant strains. These were all returned to infected premises at about 160 days, as before. Mortality from leucosis to 500 days of age was only 4.3% in the susceptible stock, but not one of the 100 females of the resistant strains died of that disease. The contrast between these figures and those for the birds exposed early in the same year shows the protection afforded by isolation. It is also evident that the dams of these isolated chicks, whether genetically resistant or genetically susceptible, did not transmit, through the egg, to their offspring any pathogen that could destroy that protection.

Altogether, these results over a 4-year period show that satisfactory control of leucosis can be attained (1) in spite of severe exposure, by using a highly resistant stock, or (2) even with a genetically susceptible stock, by rearing the birds in isolation.

Unfortunately few poultrymen can provide the complete isolation best afforded by a separate farm for rearing, and the number of strains genetically resistant to leucosis, though constantly increasing, is still far too few. However the roles of heredity and environment in the causation of this disease are not all-or-none reactions. By using the most resistant stock available, and by brooding and rearing the chicks as remotely from adult stock as is practicable, mortality from leucosis should be much less than when either of these precautions is ignored. Methods of attaining such control, and of breeding resistant stock with a minimum of risk, have been discussed elsewhere (*14, 15*).

Leucosis is a serious problem in many countries. In the United States, it has been estimated to cause an annual loss of 65 million dollars (*16*). It is not likely to be eradicated, nor can it be controlled at present by any means other than those discussed above. Animal breeders and animal pathologists have lagged notoriously behind plant breeders and plant patholo-

gists in combating disease by the development of resistant strains, but it seems highly desirable that this useful weapon be utilized in the fight against leucosis. Numerous poultry breeders are now attempting to develop their own resistant strains. Records in the first 2 New York Random Sample Laying Tests, in which chicks from leading poultry breeders are deliberately exposed to leucosis, show that some of them have already succeeded to remarkable degrees (*1*). It is to be hoped that such tests will be duplicated elsewhere, and that the encouragement thus given to the production of genetically resistant strains will eventually lead to a wider distribution of such desirable stock.

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Comments and Communications

"True" Scientists

I agree with Dr. Hammett (Science, **117**, 64, [1953]) that a degree of detachment or objectivity is desirable in the pursuit of science. However, his letter makes four points with which I cannot agree, and which I think deserve comment in times such as these. These points are: (1) that scientists practice science for diversion; (2) that "true" scientists are judged by standards different from those applied to other people; (3) that a "true" scientist should not be interested in ". . . wages, fame, or fortune . . ." or in the conditions under which he lives; (4) that "true" scientists are disappearing. For a scientist, detachment in his work is fine, but detachment from his environment may be fatal.

The *American Collegiate Dictionary* gives two definitions for "diversion," either of which, if accepted, makes me take a cloudy view of those scientists whom Dr. Hammett uses as bases for his statement: "Diversion, *n.* 1. act of diverting or turning aside, as from a course . . . 2. distraction from business, care, etc.; recreation; entertainment; amusement; a pastime." Neither of these represents the motivation of the scientists I know; are they representative of Dr. Hammett's "true" scientists?

I cannot deny the statement that a true scientist is concerned with following his vocation to the best of his ability within his capacities. So is a true sausage-stuffer or a true bank-robber. Certainly this spirit does not differentiate the scientist from his fellow humans. I object violently to the idea that the scientist is set apart from the rest of mankind by virtue of what he does. The idea of the scientist as a funny man in an ivory tower, who doesn't care of what form of government he is a part, was dispelled from the minds of scientists, press, and public by the last war. In addition to being untrue, such a belief is prejudicial to the interests of science, since in these days to be different is to be suspect.

Dr. Hammett's "true" scientist would be much too busy in his ill-equipped laboratory ever to sit with a plebeian bottle of beer (domestic, of course) and watch his small-screen table-model TV set, or to take his undoubtedly large family for a ride in the Austin. The few hours per day at home would be spent in deep thought, punctuated intermittently by trips to the outside plumbing. Who can set the scientist apart from his neighbor by stating that he cares little about the conditions under which he lives? Why should possession of a certain standard of living divert a scientist from practicing science any more than it diverts a carpenter from practicing carpentry? The professional scientist is not different from others in needing a satisfactory standard of living, in desiring rewards commensurate with his training and productivity, and in wanting to play a part in his own future and that of his family, if a "true" scientist is allowed one. Any scientist, as any other mature person who works for a living, is very properly concerned with ". . . wages, fame, or fortune . . .", since they help shape the society in which he lives.

Dr. Hammett is worried because "true" scientists are becoming extinct. I cannot dispute this, because I have no notion of what "true" may mean applied to scientists. However the race of practicing scientists is certainly increasing. I can cite, for example, the extent of support of "fundamental" research, numbers of research papers in various fields, etc. Research today is a major industry, dependent upon the output of the serious scientist.

Whatever the motivation of Dr. Hammett's letter, at least one practicing scientist disagrees with it. If

Dr. Hammett is serious, he is misled, or is living in the days of the patrons. If he is facetious, the facetiousness is untimely. The future of science and scientists in this country may well depend upon the scientists' being able to convince others that their work is not and cannot be detached from society.

J. B. KAHN, JR.

Pharmacology Department
University of Cincinnati College of Medicine

There is much sense in the Comment from F. J. Hammett (SCIENCE, 117, 64 [1953]), but I think he overlooks one vital point. The flow of time is inexorable and is likely to remain so. It is important therefore that we make good use of it and we must therefore consider to what extent the spending of money can save time and also to what extent it does so.

To take the second point first. The true scientist would find it difficult to justify any time-wasting gadget; to use Dr. Hammett's example therefore he has no business having a TV set at all whether table or console. This illustrates an outstanding defect of money; it tempts people to buy things with which they then waste time that could have been spent with more advantage and entertainment on research. But money also has the opposite quality that with it a prudent person can save time. A few "labour-saving" devices do in fact save labour; with money they can be bought and so can services of many kinds. When adequately paid, a scientist can use the most effective form of transport without worrying about the cost and he can throw things away rather than spend time tinkering with them. All that is to the good if he spends the time saved in further scientific work. This he will do if he is in fact a scientist.

The case for better salaries for scientists rests on the assumption that a productive scientist should never have to waste time to save money and so should get what money is needed to safeguard him from this. The case fails if scientists are then found to behave like their fellows and use the extra money to waste more time.

N. W. PIRIE

Rothamsted Experimental Station
Herts, England

"The breed of scientists [not interested in adequate reward for their contributions] is," according to Frederick J. Hammett, "dying out." May it!

It is a disgrace for this country that it is one of the few who by underpaying and otherwise humiliating their scholars, are undermining their own existence as civilized and free nations.

In most other countries, scholars are respected as they should be, since they are the ones who make the most important contribution to the progress of mankind. Here, one is frequently obliged to apologize to one's more highly respected fellow citizens, the salesmen and the brokers, with the bashful words, "Well, I am only a professor."

It is less the ownership of a Cadillac or a yacht which is at stake, it is the general negative attitude of the population toward learning which is based on the very fact of underpayment. Knowledge and culture, in the eyes of many, are superfluous, even ridiculous. The plumber who owns the new Packard and the salesman who owns the new Buick can only look with pity upon their learned neighbor, the professor, who can hardly afford to keep up his Austin.

This reflects itself upon the educational system since it appears obvious that highly educated persons earn little while persons who had little schooling get rich. Thus, it is not astonishing that our schools have reached the lowest standard found in the western world.

It is my conviction that low salaries for teachers and professors are one of the major contributing forces to our impending doom.

HANS ELIAS

Department of Anatomy
The Chicago Medical School

R. I. P.

There writes a man from Provincetown
With vehemence and vim
About the joys of poverty
For other men . . . not him.

He tolls the bell both loud and long
Indeed he feels the need
To note, at last, the passing of
A great and noble breed.

The scientist of yesteryear
A noble soul was he
No heed he gave to hunger's pangs
When he at work might be.

His wife attired in garments old
Was never known to fret
And if she did, he never knew,
They very seldom met.

His ragged children moved him not
What care for them had he
His mind was set on higher things
Than mere paternity.

He often toiled the clock around
Even as you and I
And gladly thanked his Maker good
That fortune passed him by.

He had no economic pains
His life it was a lark
And if he couldn't pay the rent
There always was the park.

He got his education free
He only paid with work
The process nearly wrecked his health
But taught him not to shirk.

He never dreamed of Cadillacs
While on financial skids
An Austin was sufficient for
His wife and seven kids.

His joy was all in simple things
If he had not renown
He had the admiration of
The man from Provincetown.

And when he was too old to work
That brought to him no fear
He had a princely pension of
One thousand bucks per year.

Bewail, ye winter winds, bewail
A breed that is no more
For scientists are waking up
Today they know the score.

When general practitioners
As all can plainly see
Can make twelve thousand bucks a year
They wonder, why can't we?

And if the goodly businessman
Is not destroyed by wealth
It's possible, if we had some
It would not harm our health.

For freedom from financial stress
Might let our ulcers heal
And keep our minds on scholarship
To aid the common weal.

So let us shed a passing tear
For the mighty men of old
And keep our minds on higher things
But get our share of gold.

JAMES C. BRADDOCK

Department of Zoology
Michigan State College, Lansing

DDT Detoxification Product in American Cockroaches[1]

RECENT studies (*1*) on the detoxification mechanism of DDT in American Cockroaches have revealed that as much as 55% of DDT injected into the body of a cockroach was converted to an unknown compound which did not respond to the test Shechter's (*2*) used for detecting DDT, DDE, and some of their derivatives. In this laboratory, 2-C^{14}-labeled DDT with a specific activity of approximately 1.5 mc/mM has been synthesized (*3*) and administered to cockroaches by means of injection. Among 29 of the roaches injected each with 3 μl of ethanol containing 20 μg of radioactive DDT, 22 survived after 48 hr in a respiration chamber at 30–35°. The respiratory CO_2 collected in this period was found to be nonradioactive. Practically all the radioactivity in the pulverized roaches was recovered by 80% ethanol extraction. The ethanolic extract after removing the alcohol by distillation was in water and extracted with ether for 36 hr. Radioactive assay of the extracted water phase revealed that as much as 43% of the radioactivity remained in the aqueous phase and cannot be readily removed by continued ether extractions. However, upon refluxing with 20% sulfuric acid for 3 hr, the radioactivity in this fraction was completely extracted by ether in 4 hr. This finding has led the authors to speculate that the water-soluble radioactive principle in this case is probably a conjugated compound composed of a derivative of DDT and another fragment possible carbohydrate in nature.

Similar experiments carried out at lower temperatures further indicated that the formation of this water-soluble conjugated compound was reduced to 7% at 25–30° accompanying a higher mortality of roaches over the same length of time. This could mean that the formation of the "conjugate" is directly related to the detoxification mechanism of DDT in American cockroaches. The nature of this conjugated compound is currently under investigation.

J. S. BUTTS
S. C. CHANG
B. E. CHRISTENSEN
C. H. WANG
Departments of Chemistry, Agricultural Chemistry, and *Entomology*
Oregon State College, Corvallis

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[1] Published with the approval of the Monographo Publication Committee, Research Paper No. 219, School of Science, Oregon State College.

Academic Origins of AAAS Presidents and Recipients of AAAS Awards

SEVERAL surveys have been made recently on the academic origins of outstanding leaders of American science. Sixty-seven members of the National Academy of Sciences received their undergraduate training in liberal arts colleges (*1*). One in five of the presidents of the American Chemical Society since 1900 received his training in a liberal arts college, and the same ratio holds for the recipients of ACS administered awards (*2*).

The most interesting conclusion from the present study of leaders of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE is that the same ratio of one in five of the Association's presidents since 1900 has had a liberal arts background. The eight liberal arts institutions training AAAS presidents are: Augustana, Beloit, College of Wooster (2), Denison, Hanover, Oberlin, Ohio Wesleyan, and Wesleyan (2).

Only 10% of the recipients of two of the Association's major awards are graduates of liberal arts col-

leges. The colleges training recipients of the Newcomb Cleveland Prize and the Theobald Smith Award are: Earlham, Gettysburg, Kalamazoo, Richmond, and Wheaton. And only one liberal arts college, Wesleyan, appears on both the AAAS and ACS lists of leaders.

On the other hand, several universities appear on both lists of leaders of these two large scientific organizations. Harvard ranks first in the number of presidents on both the AAAS (10) and the ACS who selected it for their undergraduate training (*3*). Yale ranks second in the number of bachelor degrees awarded AAAS presidents (4), and third in the number of ACS presidents.

Harvard has awarded more earned doctorates to AAAS presidents (7). Princeton ranks second in this distinction with five.

Holders of the AAAS Cleveland Prize and the Theobald Smith Award showed a preference for Johns Hopkins (6), Chicago (4), and New York University (3), in this order, for their doctorates.

The AAAS Program-Directory of the St. Louis 119th Meeting has been used for the roll of AAAS leaders. Biographical data have been obtained from *American Men of Science* and *Who's Who in America*. The *College Blue Book*, 6th Edition, has been employed to determine the liberal arts status of the colleges.

JOHN R. SAMPEY
JANE SAMPEY

Furman University
Greenville, South Carolina

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CORRECTION: In the paper by Haley and Rhodes that appeared on page 139, SCIENCE, February 6, there is reference to the compound Win-2299. This compound is known chemically as 2-diethyl-aminoethyl cyclopentylhydroxy-2-thienyl-acetate hydrochloride.

T. J. HALEY

Atomic Energy Project
University of California
West Los Angeles, California

Book Reviews

Isotopic Tracers in Biochemistry and Physiology. Jacob Sacks. New York–London: McGraw-Hill, 1953. 383 pp. Illus. $8.50.

The emphasis in this book is on the increasing knowledge and understanding resulting from the use of isotopes in biochemistry and physiology and not upon the actual techniques of their use. That isotopes are powerful tools is not to be doubted, and the author properly emphasizes their power by his selection of subjects and by his organization of material. He emphasizes, too, that the results obtained using isotopes must never ignore results obtained by "ordinary" (nonisotopic) techniques, but that the two must be fitted together.

After sixty pages devoted to brief accounts of the elements of nuclear physics, measuring techniques, and other background material, the author turns his attention to various fields of biochemistry and physiology in which isotopes have been used to establish new facts or elucidate mechanisms. The subjects covered in separate chapters include metabolism of carbohydrates, of lipids, of proteins and amino acids, of nucleic acids, purines and pyrimidines, of mineral elements, and of phosphorylated compounds, migrations of ions, iodine metabolism and the thyroid, and photosynthesis. The author's treatment in each case is in terms of broad outline rather than experimental detail although details are considered where they bear on interpretation. A selected bibliography accompanies each chapter, and the book includes subject and author indexes.

Some of the discussions seem likely to confuse rather than clarify. The discussion of citric acid and its orientation on an enzyme comes very close to saying that two stereoisomers of citric acid exist. It is the lack of asymmetry in citric acid which makes the Ogston three point attachment useful. Asymmetry arises through the interaction of substrate (citric acid) and enzyme.

As a consequence of the approach adopted by the author, this book will have its greatest value for those who bring a working knowledge of the general subjects to its reading. It serves to emphasize what can and what cannot be done with isotopes as experimental tools and should help in the assimilation of the mass of new material obtained by use of isotopes into the sciences to which this tool is applied.

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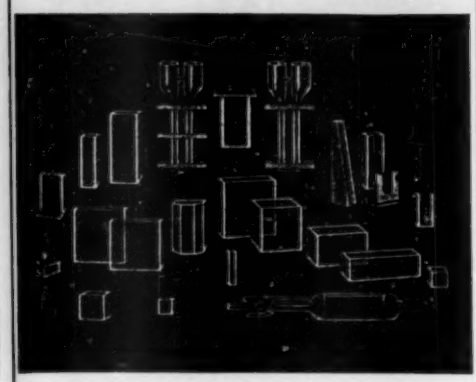

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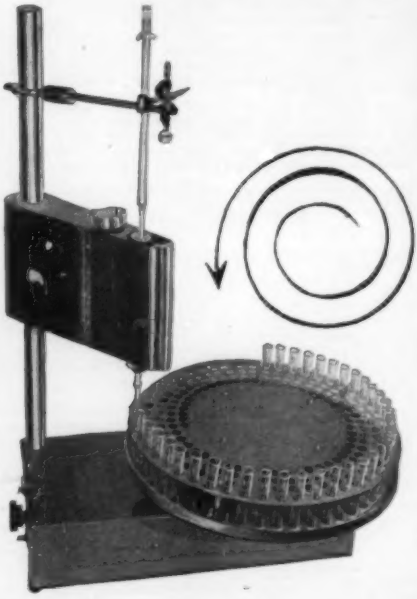

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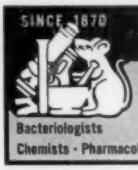

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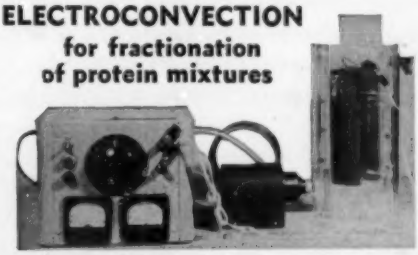

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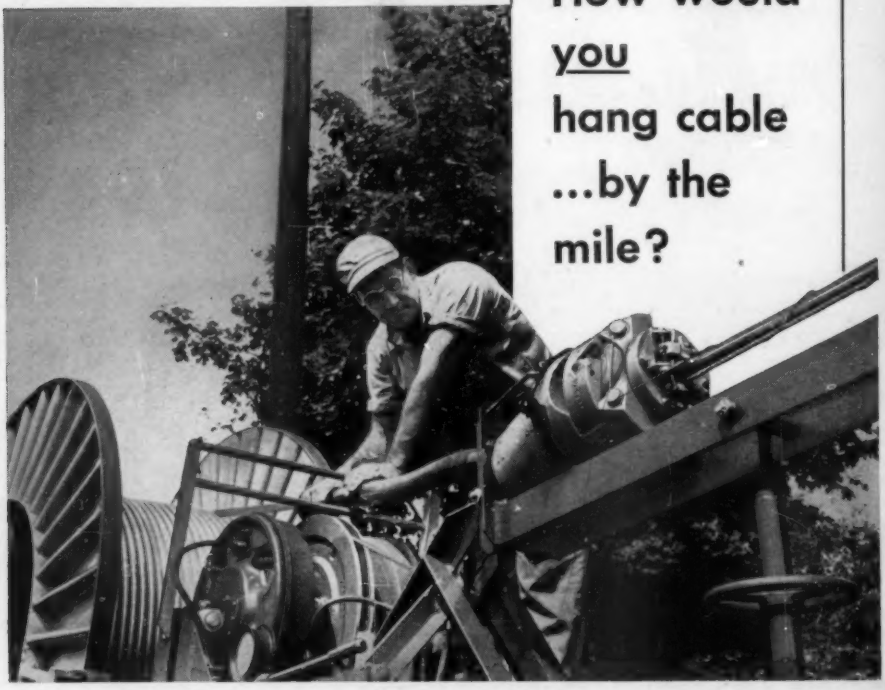

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